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STEEL MAT FOR AN EMERGENCY AIR FIELD IS QUICKLY LAID BY THE SEABEES (SEE ARTICLE, PAGE 225)

Volume 14 — *Number 6*

JUNE 1944

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Among Our Writers

KIRBY SMITH (U.S. Naval Academy, Annapolis, B.S. '06; R.P.I., C.E. '10) served in the Navy, Corps of Civil Engineers, at Pearl Harbor, Newport, and Washington, D.C., until 1920. After work with the Newport Shipbuilding Co., Asher Fire Proofing Co., and Raymond Concrete Pile Co., in 1942 he reentered the Navy. Now a Captain, he is Director of Constr., Bur. of Yards and Docks.

H. S. FAIRBANK (Cornell U., C.E. '10) has been associated throughout his professional career with the U.S. Public Roads Administration. The highway planning surveys in all states have been conducted under his general direction. He was the secretary of the National Interregional Highway Committee, and has charge of all research of the Public Roads Administration.

W. DE BERARD, city engineer of Chicago, came up through the technical editor route, having been Chicago editorial representative of *Engineering News-Record* for 31 years. Previously he was connected with various water works projects. He also served with the U.S. Reclamation Bur., the N.Y. Metropolitan Sewerage Commission, and the Chicago Regional Planning Association.

F. G. GORDON (U. of Ill., '12) has been with the Dept. of Public Works, City of Chicago, since 1941. Previously he had maintained a consulting engineering office in Chicago specializing in the design of water works structures and the appraisal of water works properties.

H. K. EGGLESTON (R.P.I., C.E. '31) had been affiliated with the N.Y. Central RR., and had acted as a private contractor and architect-engineer on general construction before going with the U.S. Engineer Dept. in 1936. He was sent to Puerto Rico to head the concrete laboratory and field-control organization in 1940. He is now on duty on construction in the Antilles.

LEON BESKIN (E.C.P. Paris, '32) has been associated with French aircraft manufacturers and general contractors and has developed applications of skin-stressed structures to civil engineering. He arrived in this country in 1941 and became connected with the Ingalls Iron Works Co. At present with Consolidated Vultee Aircraft Corp., he is developing methods of analysis of skin-stressed structures for aircraft design.

IRVINE P. GOULD (Columbia U., C.E. '36) has been engaged principally in the design and construction of large structures, particularly bridges. Field work with Madigan-Hyland included the Marine Parkway Bridge and the Bronx Whitestone Bridge. For the past 5 years he has been with Parsons, Brinckerhoff, Hogan and MacDonald, on such bridges as the St. Georges Arch in Delaware and the Jamestown, R.I., span.

ROY W. CRUM (Iowa State College, B.C.E., C.E.) has been Director of the Highway Research Board, National Research Council, since 1928. Previously he taught at Iowa State College for 12 years and served as a department head of the Iowa State Highway Commission for 9 years.

E. L. THAYER (Worcester Poly. Inst., B.S. '20) has been with the Explosives Dept. of the du Pont Company for 21 years. For the last 12 years, as technical service representative, he has given advice regarding the use of commercial high explosives in operations throughout the United States and South America.

JAMES H. NELSON (U. of Ark., B.S. in E.E. '32; A. & M. Col. of Tex., M.S. in Physics '35) has been with the U.S. Coast and Geodetic Survey for 8 years—first as a mathematician, later as a magnetic and seismological observer in Washington, D.C., and the past three years in charge of the Tucson Magnetic Observatory.

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VOLUME 14 JUNE 1944 NUMBER 6

"Seabees"—the Courageous Battalions

No Job an "Impossible" for the Construction Specialists of the U.S. Navy

By KIRBY SMITH, M. AM. SOC. C.E.
CAPTAIN, U.S.N.R., BUREAU OF YARDS AND DOCKS, WASHINGTON, D.C.

COMPLETELY at home with their bulldozers and graders, on the legendary "Island X," the Seabees are handling the tough construction tasks that are essential to the island-hopping technique developed in this war. These men have brought with them from civilian jobs technical skills that have time and time again eliminated trouble spots. Fighters all, they are prepared to defend if need be the works they have built. This report by Captain Smith was presented before the Construction Division at the Annual Meeting of the Society in New York, January 1944.

THE Seabees are a part of the Navy's Civil Engineer Corps which, under the leadership of Vice Admiral Ben Moreell, Hon. M. Am. Soc. C.E., administers the construction and maintenance of all naval shore establishments. Within the continental United States this work can be done by civilians, but in the theaters of operation, where bombing raids and sneak attacks by a desperate enemy are an ever-present menace, it must be carried through by men trained and equipped not only to work but also, whenever the necessity arises, to defend their lives and the results of their labors. These are the Seabees—construction men in uniform, furnished with guns and grenades as well as with tools and equipment, and equally facile in the use of either.

There is no need of explaining the importance of shore bases to the fighting ships and aircraft of the fleet. Under the stress of battle, fuel, ammunition, and other supplies are rapidly expended, and must be replenished. Wounded personnel must be cared for, and damaged ships repaired. All this must be done on shore, at bases staffed with trained personnel, stocked with supplies, and equipped with tools and machinery. The closer such support is to the actual scene of battle, the less time is lost in fulfilling these needs. Hence, the establishment of advance bases is equivalent to increasing the number of ships and aircraft available for combat operations.

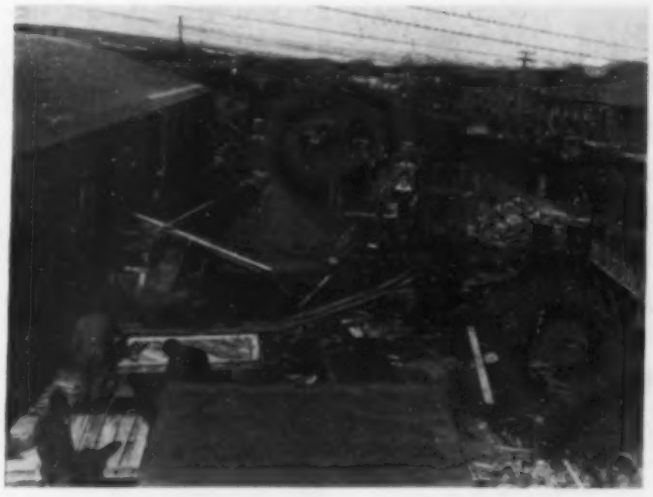
Providing these advance bases is the primary job of the Seabees. They build the Naval air bases which serve to bring air bombers and fighters ever closer to their targets. They build the fleet's fueling bases and machine shops. They work against time and under enemy bombs to unload ships of their essential cargoes. They build the roads, the utilities, the docks and wharfs, the warehouses, and all the other installations needed to support our fleet and air operations. They have also been trained to fight and to defend what they build.

Above all, the Seabees are a Naval organization. Much of their work consists of building advance base facilities for the fleet. But fleet installations nowadays mean air fields and hangars as well as piers and marine repair shops. The Navy's powerful air arm is striking hard—and its hidden nests are Seabee built.

In 1916, twenty-eight years ago, a far-sighted officer of the Civil Engineer Corps, U.S.N., which today fur-

Official Navy Photo

PALMS MAKE WAY FOR AN AIR STRIP AS THE SEABEES TAKE A STEP NEARER TOKIO



Official Navy Photo

WORKING IN ALL CLIMES, THE SEABEES BUILD THE BASES FOR FUTURE ASSAULTS

nished most of the officers for the Seabees in the field, said flatly, "The coming world influence of one great dominant thing that will overshadow all else will be air superiority and power." That officer was Rear Admiral Peary, famous as discoverer of the North Pole. The air fields of the Aleutians, the Caribbean, and the South Pacific are testimony to his vision.

The Naval Construction Battalions are among the youngest of all the branches of the armed services. A new organization, they had no storied tradition when they began less than two years ago, but they certainly have now. It's a rugged tradition of adaptability, technical skill, dogged determination, and flashing courage. Two years ago, the Seabees' authorized strength was 3,300. Today the battalions are within close range of their new goal of 267,000 officers and men. Nearly half are already overseas; the remainder, now in training, soon will be on their way.

The stout-hearted construction men who comprise the Seabees' enlisted personnel are a unique breed. Most of them have volunteered—given up good paying civilian jobs, declined strong draft deferments, temporarily taken leave of their families, to pitch in on an assignment they knew they could do better than anyone else. A goodly number, over the draft age, are veterans of the first World War. The men who built the Empire State Building, who worked on the Golden Gate Bridge, who laid down the Pennsylvania Turnpike; the men who built the skyscrapers, bridges, tunnels, roads, and public works of America—these are the men who enlisted in the Seabees.

Almost every Seabee is a specialist. In civilian life he may have been a superintendent, foreman, or head of his own construction company. He may have been a blacksmith, plumber, or electrician. He may have repaired automobiles, strung telephone wires, or driven a heavy truck. And in the Naval Construction Battalions he puts that skill to use in a vital military assignment. Each Seabee battalion has a place for men skilled in 59 necessary construction crafts and trades. The Seabees have what is probably a higher proportion of rated specialists than any other branch of the armed forces.

Included in the 1,079 men in the typical Seabee battalion are 896 trained construction workers, organized into four companies of 224 men each, and 176 "headquarters" men—draftsmen, bakers, cooks, gunners, yeomen, storekeepers, barbers, mail clerks, etc.—who comprise a separate headquarters company. The battalion's 32 officers include 26 Civil Engineer Corps officers, two doctors, a dentist, two supply and disbursing officers and a chaplain. When two or more battalions operate in the same location they are formed into regiments and even brigades.

Seabee training is, to understate it, rigorous. Instructors school the construction men, most of whom already have been hardened by long years of outdoor work to defend themselves against attack from any quarter. Eight weeks after they pass through the gates of Camp Peary, Naval Construction Training Center at Williamsburg, Va., these men not only are ready to do a skilled building job, but also, if necessary, to fight shoulder-to-shoulder with the Marines, the Army, or the Navy. This initial training is almost entirely military. The men are assumed to be skilled technicians at the time they enter the Naval Construction Battalions. What they learn now is how to be top-flight fighting men as well.

Seabee recruits are drilled in the handling of rifles, carbines, machine guns, and even the smaller field pieces. They receive instruction in the use of the machete, the wide-bladed sword with which Filipino fighting men split Jap skulls at Bataan. They are seasoned in the "kill or be killed" code of jungle fighting. When the Seabees depart for "Island X"—now the legendary destination of all Seabee battalions—they are ready both to build and to defend their advance base.

SPECIALISTS ALL

This second World War has often been referred to as a war of specialists. The Naval Construction Battalions in themselves certainly are a specialized organization. Yet front-line experience has shown the need for additional highly skilled units within the general Seabee framework, trained to break the other kinds of advance-base bottlenecks. As the first Seabee-constructed bases swung into operation, existing native labor, plus whatever naval units could be spared from their regular duties, could cope with the growing port and stevedoring problems involved in the quick, efficient unloading and dispatching of ever-increasing quantities of war material.

Official Navy Photo

STABILIZED SOIL HAS BEEN USED WIDELY FOR AIR STRIPS IN ALL CLIMATES

At one time, 66 cargo vessels were lying off a South Pacific island, their valuable cargoes immobilized while hastily assembled unloading crews fell further and further behind. Meanwhile, despite all possible dispersal tactics, the ships were inviting targets for the Jap bombers overhead. That was the situation when a Seabee "Special" Battalion, trained in loading and unloading war material, arrived and quickly took over. Within a month the "Special" had emptied 31 vessels; today they are unloading ships as fast as they come in.

Although many of the men in the Special Battalions had no cargo experience prior to joining the Seabees, careful training and an enthusiasm for their work have made these crews a match for professional longshoremen at home. The Seabee stevedores and longshoremen learn their trade in a unique training school at Camp Peary. Their "classrooms" are two land-built training ships, complete with all Liberty Ship gear.

The Seabees are also involved in what so far appears to have been one of the war's "best-kept secrets." "Ranger" and "Commando" are familiar terms in almost every American household. The public knows how these fearless assault units spearhead Allied invasion. But somehow the spotlight has missed a group of men who often go into action even before these hand-picked forces.

UNDERWATER DEMOLITION

The terrifically dangerous job of removing obstacles to landing operations, whether they are above water or below, before shock troops hit the beach, has been assigned to Seabee demolition units. The Seabee demolition men are all volunteers for this hazardous assignment. Working in groups of five—four enlisted men and an officer—they steal ashore in advance of the first assault to blast or otherwise clear the way for the ships and men to come. The work of the Seabee demolition units is essential to offensive operations. They did their job at Salerno and Tarawa; they will be in the forefront of still bigger invasions to come.

Almost every Marine division has a Seabee detachment with it. Wearing Marine uniforms and standing shoulder-to-shoulder with the leather-necks when the initial assault is launched, the Navy's hard-hitting construction force often moves in under heavy enemy fire to help take over the sites on which advance base construction will immediately begin. A Seabee battalion which continued its work on Guadalcanal while taking all the Japs could throw at it received a Presidential Citation for its remarkable record.

Still another specialized cog in the Seabee organization is the Construction Base Maintenance Unit. Each such unit numbers 270 men and 5 officers. Its function is to take over the maintenance of an advance base already in operation, thus freeing an entire battalion for further new construction.

New construction means another "Island X." And for a Naval Construction Battalion the destination may be anywhere—a pin-speck atoll in the South Pacific; a barren, ice-bound island in the Aleutians; a mine-strewn beach in Italy; perhaps a teeming seaport in India. For one of the first Seabee battalions, "Island X" materialized as a tropical hell-hole that newspaper readers later identified on page-one maps as Guadalcanal—"X" marks Henderson Field.

Henderson Field, started by the Japs but taken over by the Seabees, and completed against a background of continuous Japanese air assault, was one of the first and perhaps the most famous project to bear the Seabee trademark. There have been many others since—air fields, docks, fortifications, military installations of al-

Official Navy Photo

BEARDED SEABEES ARE PUTTING ROOFS OVER THE HEADS OF FIGHTING MEN AT GUADALCANAL

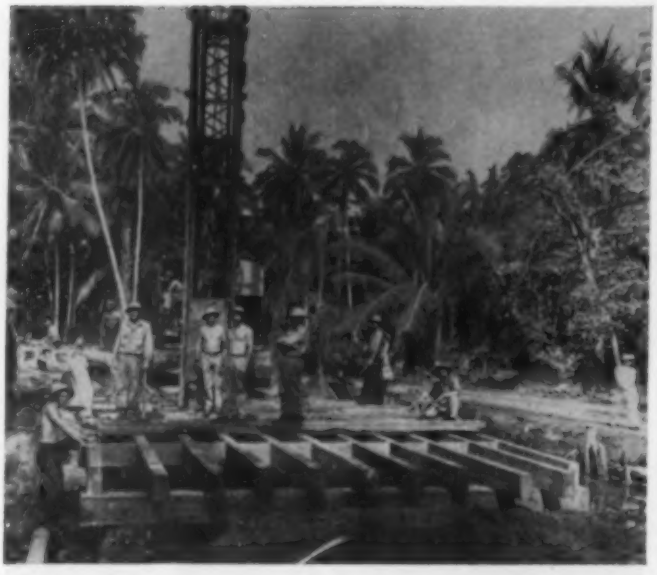
most every description—some already in operation for many months but closely guarded military secrets, others just under way in jungles where dead Japs, still unburied, comprise a grim and thoroughly unappreciative audience.

Seabee construction is basically a behind-the-scenes affair. But these tough-muscled builders are ready to fight when they have to—and they really "pack a wallop." A Marine who is a veteran of several overseas campaigns wasn't fooling when he said to a newly enlisted Seabee, "Brother, you sure picked yourself a rugged outfit."

SEABEES IN THE SOLOMONS

In the Solomons when the Marines, short of men, temporarily had to evacuate a section of the front line, they asked the Seabees to take over—and the battling builders held on for three days and nights. At Salerno, when the first shock troops waded in to the beach, Seabee demolition units already had exploded their charges in the face of enemy fire, and other Seabees were standing up before merciless shelling and strafing to unload more than 10,000 pieces of equipment from the invasion craft constantly coming in. At Rendova a Seabee detachment was on the beach with the first assault wave. In the Aleutians and in North Africa, men from the Naval Construction Battalions were in at the beginning of the show.

Yet the real story of the Seabees is told not so much in battles as in work, sacrifice, and ingenuity. It takes tremendous courage to reach and hold the high emotional peak at which a soldier goes over the top; it takes another equally real kind of courage to plug along for a year or more at a stretch in a disease-infested jungle or a storm-ridden Aleutian wasteland, braving snipers' bullets, shells, and bombs. One battalion worked through



Official Navy Photo

FROM THEIR JOBS BACK HOME, THESE CONSTRUCTION SPECIALISTS HAVE BROUGHT A KNACK FOR USING MATERIALS AND EQUIPMENT EFFICIENTLY

238 bombings in 240 days and nights—and still retained the dogged determination to get the job done as quickly and as well as possible, come what may.

INGENUITY PLUS

Quick thinking and the old Yankee ability to get the job done regardless, characterize all Seabees no matter where they are or what problem they face. They have repaired airplanes, welded a new stern on a damaged warship, made emergency repairs to an aircraft carrier under fire, and done many other equally brilliant things not strictly in their usual line of duty. In one case they were called upon to make emergency repairs on a propeller and, unable because of lack of equipment to remove the 2,000-lb screw from the ship, the Seabees used their two available raw materials, dynamite and mud packs, to blast the propeller loose. They then carted it off triumphantly to their improvised repair shop for a successful overhauling.

Perhaps, after this war, it will be possible to tell more about the specific installations the Seabees are now rushing to completion—and when it is told, these courageous builders will come in for their share of glory. But right now, pounding pulverized coral into a smooth, safe air strip on some outlying island way-station may be an unappreciated job—unappreciated until the airfield becomes the jumping off place for tomorrow's headlines.

The advance bases constructed by the Navy Construction Battalions generally fall into two categories—those for the support of ships and those for the support of aircraft. One of the larger advance bases, already established, has a capacity equal to some of our smaller continental Navy Yards. Such a base is capable of handling voyage repairs and minor battle-damage repairs on all classes of Naval vessels, including submarines. Ship repair bases are usually provided with floating dry docks for under-water repairs. These are available in a range of sizes from the 100,000-ton advance base sectional dock to the small pontoon dry docks of 100-ton capacity for PT boats.

By far the largest construction job at advance bases is the preparation of airfields for fighters and bombers. In extensive areas of the South Pacific islands, coral is available for surfacing these fields, and sometimes it is found in place at a depth of less than 2 ft below the present surface. In these cases, it has therefore been possible to surface the fields entirely with local materials.

ACRES OF STEEL MAT USED

More frequently, however, it is necessary to surface the finished grade with either asphalt, stabilized soil, or steel landing mat. The speed of laying the steel mat is vastly greater than the best speed obtainable with stabilized soil. The only danger is that too much will be expected of the steel mat and the subgrade will not be properly consolidated and leveled off. The steel mat is purposely made flexible, and a bearing power of the soil of at least 4 tons per sq ft is necessary to maintain a permanently smooth steel plant surface. It has been proven possible in emergencies to provide landing fields, even for bombers, by laying the mat directly on a soil having a bearing power of less than 1 ton per sq ft. These fields generally require later consolidation by working gravel through the holes in the mat, or as was done at one field, rolling the mat back, scraping out the soft material, and putting in gravel.

The Construction Battalions have been successful in doing all classes of work called for in connection with the building of advance bases from Iceland to New Georgia. They are not used in the continental United States except for purposes of training or in emergencies.

Possibly the best criterion of the work of the Seabees is the opinion of the men who are in a position to know the facts. A few such opinions are cited. In a letter to Admiral Moreell, Chester W. Nimitz, Admiral of the U.S. Pacific Fleet, on October 5, 1943, wrote: "Once again I cannot too strongly emphasize the appreciation which we all feel for the vigorous, cooperative, and imaginative way in which you and your corps are helping us in this Pacific war. The Seabees continue to distinguish themselves wherever they may be found throughout the Pacific Ocean areas, as do also your officers of the Civil Engineer Corps."

Lieutenant General A. A. Vandegrift, Commandant of the Marines, had this to say: "I wish to commend the wisdom that foresaw the need for such an organization. In the war in the Pacific in seizing one base after another, few of us realized the great amount of construction which would be necessary. I do not know how we would have gotten along without the Seabees and trust that they will be participants in every future operation in even larger number than at Guadalcanal."

The Hon. Frank Knox, the late Secretary of the Navy, had this to say: "Every major amphibious operation of the Navy has found Seabees among the first to land. Almost every airfield, supply depot, or other installation the Navy has built since Pearl Harbor has been a Seabee record for speed and ingenuity. And in bitter battles like Guadalcanal or Tarawa, you have shed your blood to earn a share of victory."

In my opinion the extraordinary success of the Seabees has been due to two principal factors: First, the men continue to do the same work that they did before they enlisted in the Navy, and second, they are headed by officers who know construction and speak the same language as the men.

More and more frequently, the word "Seabees" crops out in news dispatches as fresh invasions and advances are launched. With the United Nations now definitely on the offensive, the frequency of these stories can be expected to increase. Read them with pride, for these are American engineers and construction men, who are making an outstanding contribution toward that final victory for which we are all striving.

American Inter-Regional Highway System

II. How It Meets Postwar Needs

By H. S. FAIRBANK

DEPUTY COMMISSIONER, PUBLIC ROADS ADMINISTRATION, FEDERAL WORKS AGENCY, WASHINGTON, D.C.

COMPREHENSIVE highway planning, illustrated by the government-recommended system, admirably fits into the postwar program visualized by the Society's committee, says Deputy Commissioner Fairbank. The aim, he believes, should be not merely to replace present structures, but to envision long-range modernization of the highway network. The adopted national system provides a master plan for immediate, as well as future, guidance. This paper, presented before the joint session of the City Planning and Highway Divisions at the Society's Annual Meeting, supplements the one in the May issue by Commissioner MacDonald, detailing how the proposed enlarged highway system dovetails into the postwar needs of cities.

IN a timely statement published in the September issue of CIVIL ENGINEERING (pp. 439–442), the Society's Committee on Postwar Construction outlined certain basic principles that should be observed in the planning of a postwar construction program, and defined some of the major elements that such a program should include. The Society advocated the planning of a sound program of useful public works as part of the preparation essential to insure the reemployment of soldiers and displaced industrial workers after the war; and suggested the immediate completion of all preliminaries—in the form of engineering, real estate, legal, and financial arrangements.

This calm counsel of the Society stands out among many more emotional proposals as a reasoned guide to effective action. It is appropriate to observe that the course it charts is precisely that followed in shaping the provisions of recently enacted and pending federal highway legislation.

I refer particularly to the provisions made: (1) for advance planning, by the Defense Highway Act of 1941 and Public Law 146, enacted last July; (2) for federal participation in the costs of rights of way, by Public Law No. 146; and (3) for planning, right-of-way acquisition and the financing of postwar construction, by the bills now pending in both Houses of Congress, designated S. 971 in the Senate and H.R. 2426 in the House.

Of these several provisions, the most remarkable for its farsighted anticipation of future needs is that of the Defense Highway Act. Passed a month before our declaration of war, this Act authorized a federal expenditure of $10,000,000, to be matched by an approximately equal expenditure by the states, for surveys, plans, specifications and estimates for future construction on the strategic highway network and on routes in, through, and around cities.

To this early provision for advance planning, limited to particular classes of projects, Public Law No. 146 added permission to expend in each state otherwise unobligated amounts of an apportioned national total of $50,000,000 of federal funds (previously available for construction only) for surveys, plans, specifications and estimates for postwar street and highway improvements, without restriction of class or system. Thus at least $25,000,000 of federal funds, matched by an approximately equal sum of state revenue, may be devoted to the authorized planning projects. The total of roundly $50,000,000, added to the $20,000,000 previously authorized, will provide for the detailed planning of postwar highway and street construction a grand total approaching $70,000,000. Assuming a 4% planning cost, this promises plans for postwar highway and street construction amounting to $1,750,000,000. And, let it be emphasized, this generous provision is available for the planning of rural roads and city streets, main arteries and their feeder connections, with no restriction whatever within the limits of a well-balanced program.

Thus, in the highway field, federal legislation alone makes substantial provision for the preparation of working plans, specifications, and contract documents—first of the three categories of preliminary work declared by the Society's Committee on Postwar Construction to be essential to the prompt undertaking of construction at the end of the war.

For work in the second category—the acquisition of rights of way—the amendment of the Federal Highway Act incorporated in Public Law No. 146 makes the essential basic provision. It signifies the importance attached by the government to adequate rights of way for future highway improvements, and promises full federal cooperation in meeting such costs for projects hereafter to be constructed with federal aid. What is needed further is the assurance of postwar federal construction appropriations, and this is one of the purposes of the bills now (May 1944) pending in Congress

These federal bills also aim to accomplish the third of the conditions which the Society has declared to be essential—that is, the completion of legal and financial arrangements for the beginning of construction promptly at the end of the war. They authorize federal appropriations of $1,000,000,000 for each of the first three postwar years, and prescribe the manner in which such funds are to be apportioned and matched by the states, and the purposes for which they are to be expended.

There is good reason for the confident expectation that these bills will emerge as adequate and effective legislation within a reasonably short time. So far as it can be done by legislation and financial authorization, then, the federal government either already has made, or is about

Courtesy California Highways and Public Works Magazine

FOR INTER-CITY TRAFFIC—MARGINAL ROADS, AND MANY GRADE SEPARATIONS

Arroyo Seco Parkway, Los Angeles to Pasadena, Calif.

EASTERN STATE PARKWAY NEAR FISHKILL, N.Y.
Separate Roadways, Sometimes at Different Levels, Are the Proposed Standard for a Daily Traffic of Upwards of 3,000 Vehicles

to make, adequate provision for all the preliminary work rightly held by the Society to be essential to the prompt undertaking of a postwar highway program.

It must now be acknowledged that in the application of the available legal and financial provisions, there has been unexpected and disturbing delay. On December 31, 1943, only $6,200,000 of the federal $10,000,000 available for advance planning since November 1941 had been allotted, with matching state funds, to definitely programmed surveying and planning projects. Of the similar provision by Public Law No. 146, available since July 1943, very little has been applied in active work. The highway departments of 28 states and the District of Columbia have thus far advised the Public Roads Administration (PRA) of their intention to use for survey and planning purposes about $16,000,000, matched by $14,000,000 of state money. Four state highway departments have announced that instead they will reserve their funds for eventual construction, financing the advance planning with state funds only; and 16 state highway departments have given no official notice of their intention to use any of these funds for planning purposes.

The amount of the federal planning funds put to work, of course, does not measure the full extent of the highway planning that has been undertaken. Probably in all states some planning has been projected or completed, without federal funds—planning undertaken, if not by the state highway departments, at least by some of the cities and other subdivisions of government. Even so, the fact remains that the unexpectedly slow rate of allotment of the federal planning funds does mirror the effect of several delaying causes that have probably retarded the whole highway planning operation.

MANY HANDICAPS OPERATE

One of these causes has been the heavy loss of trained engineering personnel and the preoccupation of the remaining forces with access road construction and other work immediately essential. Another reason—more effective a year ago than now—has been a general belief that the war would be a long one and a feeling of the futility of definite planning for a vague and uncertain future.

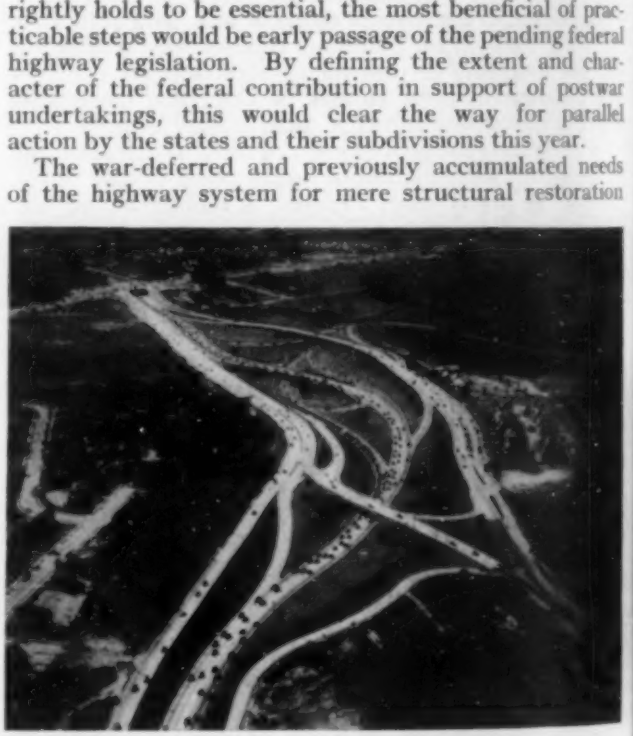
A third and very important cause has been the uncertainty as to the amount of road building funds to be available and the conditions attached to their expenditure. In part, this uncertainty has resulted from the difficulty of anticipating the extent of the decline in road-user revenue during the war, and the rate at which these revenues, forming so great a part of the support of road-building operations, may be expected to increase when the war is over. To some extent, also, the uncertainty has been due to the break in the chain of federal-aid authorizations and the impossibility of knowing in what amount, and under what conditions, this aid will be restored.

And finally there has been the lack of an effective working relationship between the state highway departments and the planning and highway authorities of cities, and a want of decision in the cities themselves as to the character and location of their important arterial routes. It is generally agreed that the connections of main highways across and around cities constitute some of the most serious deficiencies in the present highway system. The PRA has strongly urged that the adequate improvement of these connections be given a prominent place in programs for expenditure of the highway planning funds available under the two federal acts. But, although most of the state highway departments agree, and desire to expend substantial amounts of the available funds for these purposes, the absence of well-established cooperative relations with the cities, and a mutual unreadiness for the decisions involved, appear to have delayed many of the undertakings.

These causes have also been among the first and most influential in the pronounced delay in right-of-way preparation. And, in this connection, uncertainty as to the extent of future federal participation has undoubtedly had an important effect.

To resolve these uncertainties and speed the preliminary work which the Society's statement of policy so rightly holds to be essential, the most beneficial of practicable steps would be early passage of the pending federal highway legislation. By defining the extent and character of the federal contribution in support of postwar undertakings, this would clear the way for parallel action by the states and their subdivisions this year.

The war-deferred and previously accumulated needs of the highway system for mere structural restoration

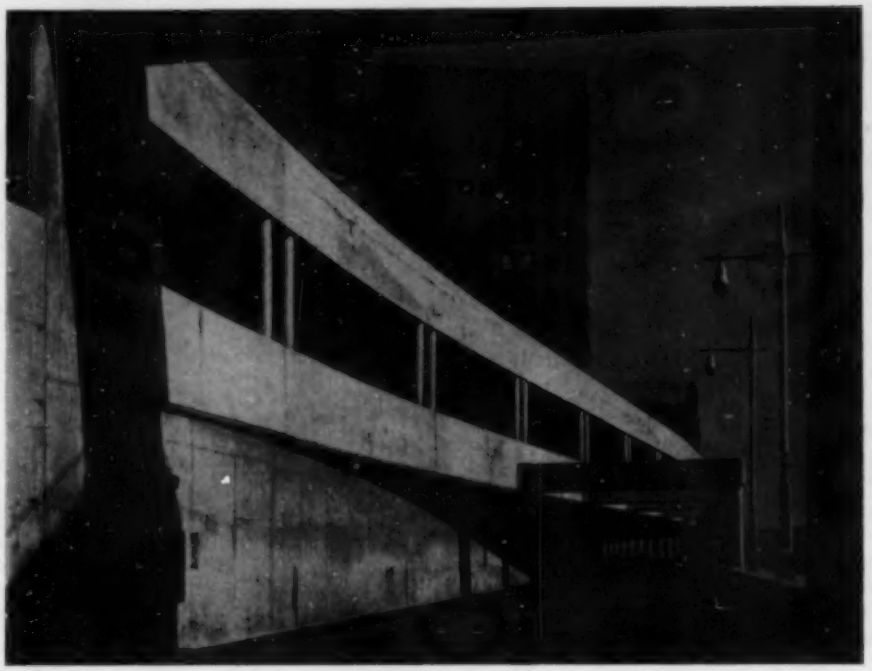


Dept. of Parks, City of New York

NEAR CITIES, TRAFFIC SEPARATION IS IMPORTANT
At Least Three Main Expressways Intersect at Kew Gardens, New York City

are so great that, were we content to replace roads and bridges in their present locations and capacities, preparations for a large postwar construction program would not be particularly difficult or time-consuming. In total, these maintenance operations alone are likely to require expenditures at a rate of above 750 millions a year. A much larger construction program, directed simply to the rebuilding of worn-out roads and bridges in situ and in kind, could be prepared with comparatively little effort. Together with maintenance operations, this would assuredly furnish employment for large numbers.

If employment were the primary aim of a postwar highway program, it would be reasonable, perhaps, to limit at least the earlier construction undertakings to projects thus easily planned. A sounder view is that employment should be subordinated to efficient and adequate highway improvement; that construction after the war should supply properly placed and adequately designed units different from, and better than, those which exist at the present time.



Dept. of Boro Works, Office of Boro Pres., Manhattan, N.Y.

SPREADING VERTICALLY INSTEAD OF HORIZONTALLY
Transition to Double-Deck Section on East River Drive, New York

Need for this modernization has been widely recognized for almost a decade. The depression and the war have delayed it over long. It will be lamentable indeed if by hasty and ill-considered action, substantial (perhaps extraordinarily large) postwar means are misdirected to timid, misplaced, and merely provisional construction. This will not only lead to failure to realize a beneficial plan but, far worse, will add to the mass of obsolescent facilities that must be liquidated.

In this connection, the Society's policy statement refers to two basic views as to the planning of postwar public works—one, the long-range view, looking toward farsighted objectives; and the other, the more realistic, shorter-range view, envisaging projects needed at once. The implication is that the two views are mutually inconsistent. As applied to a postwar highway program, they are not alternatives, but, on the contrary, are helpfully complementary, and are both to be encouraged. It would be most unforunate if the Society's statement were to confirm a tendency in highway planning toward the too ready acceptance of what is immediately expedient, and discourage as impractical and idealistic immediate action for the realization of enlightened long-range objectives. Improvement projects cannot be casually selected to fit into all long-range plans. On the contrary, the formulation of particular, well-considered, and feasible long-range plans is the most important of present needs. Only such long-range plans can prevent the wasteful and haphazard expenditure of large amounts of highway funds in the postwar period.

THIS TEXAS ROAD TYPIFIES DESIGN FOR TRAFFIC OF NOT OVER 1,000 VEHICLES A DAY
Pavement Is 24 Ft Wide, with Wide Shoulders and Easy Slopes

COMPREHENSIVE PROGRAM AVAILABLE

For two decades the highway program has been fortunate in possessing just such long-range plans, as represented by the designated federal-aid and state highway systems, and the policies consistently followed in the progressive improvement of these systems. It is unfortunate that these long-range plans, adequate as they were for an earlier stage of highway and street development, have not been revised and broadened, as they now should be, to meet the modern need.

In the middle thirties, highway planning surveys were undertaken by the states and the PRA to establish a factual basis for replanning to secure long-range objectives. The overpowering conclusions to be drawn from the facts amassed are that there is a notable lack of balance in highway development resulting from the preceding years of pioneer effort, and that there is danger that this unbalanced development will be continued in the absence of a more concerted plan of attack on the problem as a whole. And subordinate only to these is the conclusion that the time is long since ripe for scrapping earlier provisional policies and methods and adopting new policies, methods, and plans giving greater assurance that whatever is henceforth done in improving any part of the whole highway and street system will contribute lastingly and in its proper place toward the balanced development of the whole. It is inconceivable, for example, that temporary obstacles of land acquisition should be permitted to confine the reconstruction of important existing highways for another

STANDARD FOR INTER-REGIONAL SYSTEM—A RURAL INTERSECTION
Wide Median Strip, Accelerating and Decelerating Lanes, and Other Improvements

twenty years within cramped rights of way on dangerous, indirect, and capacity-reducing alinement. Yet unless there is revision of some of our broader policies, and a new recognition of long-range objectives—by the public at large as well as by highway engineers—there will continue to be many such ill-advised reconstructions to prevent efficient traffic movement for years to come.

LONG- RATHER THAN SHORT-RANGE VISION

Clearly a long-range program that provides for improvement of only part of the whole highway and street system, as do the state and federal-aid programs in their present conception, will not suffice. A policy that establishes intergovernmental relations and means of financing for such a partial program, leaving the improvement, the financing, and the administration of other essential parts to the casual and unrelated decisions of many times, places, and persons, will fail to bring about the balanced and adequate improvement of the whole system that should be the goal of all effort after the war.

Hurrying to be ready with specific construction projects immediately after the war, we are apt to make the mistake of thinking of the postwar period as only a short period of emergency. It will make for sounder planning if we think of it rather as the beginning of a long period of constructive peace; and of the first years as years into which it will possibly be consonant with good economic policy to compress an extraordinarily large amount of the new highway construction which the future will require.

So thinking, we shall see this immediate work as the beginning of a new orderly process, rather than as just another of the expedients that have so confused the progress of highway development in the last decade. We shall make early and intelligent adjustment of highway plans and policies to secure a better coordination of the several modes of transportation—highway, rail, air, and water.

We shall untangle the unnecessary confusion of conflicting state limitations in size, weight, and speed of motor vehicles, thereby establishing both the basic conditions to be met in future highway and bridge design, and the restrictions essential to the prevention of damaging use. This means also the setting up of unambiguous standards for the manufacture of motor vehicles, and the removal from highway transportation of the unwarranted impediments which now obstruct it at numerous imaginary lines.

We shall recognize the finite limit of highway cost payable with road-user taxes; and suspend the rule of blind grab in dividing these taxes between federal, state, county, and municipal demands, using them instead in balanced proportion to meet predetermined needs.

We shall review the present irrational classification of the highway and street system and effect a more reasonable division of the total mileage among administrative systems, determining in the same process the probable total extent of the improvable mileage, and the relative importance of the constituent parts of each system.

Between state, county, and municipal highway authorities, we shall establish cooperative relations as close and efficient as those that have long existed between federal and state agencies, and create new and effective authorities to deal with the complex planning and improvement of highways in metropolitan areas where recognized governmental jurisdictions overlap.

By organized deliberation and agreement, all levels of highway authority participating, we shall endeavor to establish for the several orders of highways and streets consistent standards of design to be applied alike in all states and communities.

We shall modernize our antiquated right-of-way laws and practices, and make adequate legal provision for appropriate application of the principle of limited highway access, creating the wider, straighter, and more free-flowing arteries that will be necessary for safety and convenience under conditions of future traffic volumes and speed.

MASTER PLAN FOR NATIONAL USE

It is the chief merit of the report of the National Inter-Regional Highway Committee, transmitted by the President to the Congress, that it envisions most of these more fundamental preparations as essential, equally with the more detailed engineering of early postwar construction projects, for the sound and efficient planning of an inter-regional system. The routes proposed, though they would serve, if improved as contemplated, at least 20% of the total highway movement, represent only 1% of the total mileage. But in recommending the essential means for improving this small part of the whole highway system, the Committee has outlined the essential principles of a complete master highway plan, and by example has demonstrated the methods that may, and now should be, employed in similarly planning other and larger portions of the total street and highway network.

The Inter-Regional Committee has demonstrated that there is more—much more—to postwar highway planning than the surveying and designing of casually selected projects for a year or two of construction succeeding the war. For an important part of the highway system, it has planned the foundation for a postwar improvement program providing for both immediate and continuing action toward a clear future goal. It has set a pattern that ought now to be applied with the least possible delay, and with the utmost of intergovernmental faith and cooperation, to the completion of a postwar program for the balanced improvement of all segments of the street and highway system of the country.

War's Impact on a Chicago Filtration Plant

By W. W. DeBERARD *and* F. G. GORDON, MEMBERS AM. SOC. C.E.
RESPECTIVELY CITY ENGINEER AND SENIOR FILTRATION ENGINEER, CITY OF CHICAGO, ILL.

BOTH the necessity and the difficulty of obtaining potable water for Chicago near its Indiana boundary are critical. The city began construction of its South District Filtration Plant to maintain the integrity of its water supply. When it was half completed, the advent of war dislocated orderly construction procedures. This paper, presented before the Sanitary Engineering Division at the Society's Annual Meeting in January, described Chicago's attempt to continue construction of the plant and to secure some reduction in the pollution of the raw water at its South Side intake.

VALUABLE engineering experience has been gained and lessons are still being learned in one of Chicago's great water supply projects—the South District Filtration Plant. The story goes back to September 19, 1938, when bids were received for the initial contract. With the opening of these bids the city began a construction program which had been long in the making and whose completion was to become dependent on the course of events in little-known isles half way around the world.

Chicago, the first of the larger Great Lakes cities to embark on a major program for the disposal of its sewage, became the last of these same cities to filter its water supply. The two events, although separated by nearly a half century chronologically, are not unrelated. The concept of the Chicago Drainage Canal was daring, and its construction a spectacular feat. The flow in the main channel of the Chicago River was reversed and through the medium of water diverted from the Lake, the city's sewage was diluted and carried through the south branch of the river, the drainage canal, and into the Illinois River near Joliet, Ill.

The results, while highly satisfactory from the standpoint of public health, were less so from the standpoint of litigation. The net effect of over three decades of litigation was an order by the Supreme Court of the United States to reduce the amount of diversion. Time was permitted the city to construct sewage disposal plants for sewage not already treated. The stepped reduction in diversion was carried out strictly in accordance with the order of the Court, but inability to finance the construction project during the depression resulted in some delay in completing the sewage disposal plants.

In the meantime Chicago was taking the preliminary steps leading to the construction of its first filtration plant. As early as 1928 an experimental plant was built to investigate the best and most economical methods of treating Lake Michigan water. Enabling legislation was secured in 1935 to finance the plant and to construct it on the lake shore. A grant was received from the Federal Emergency Administration of Public Works in 1938, and construction actually started shortly thereafter.

A peculiar quirk in Chicago's geographical position was responsible for the decision to have the first filtration plant serve the so-called South District. Chicago is bounded on the east by Lake Michigan and the State of Indiana. In this northwest corner of Indiana is located a part of one of the great industrial districts of the world, known as the Calumet area. Its rapid growth far outstripped its ability to handle affectively its sanitary sewage and industrial wastes, with the result that these are the cause of gross contamination in Lake Michigan. The proximity of the South Side intake to the lake pollution originating just across the state line in Indiana left no question about either the necessity of, or location for, Chicago's first filtration plant.

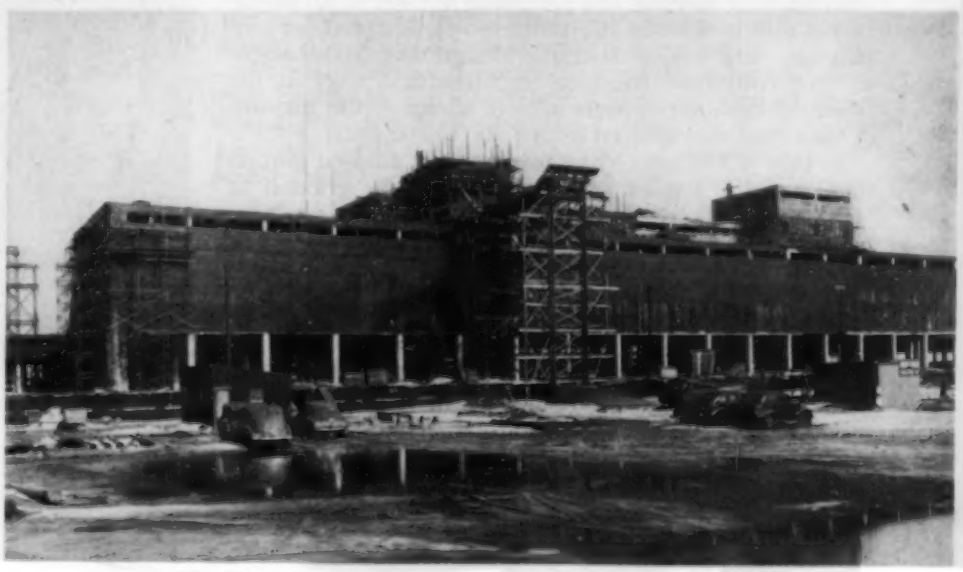
The location selected for the plant (Fig. 1) was on the shore of Lake Michigan near 79th Street. The plant was designed for a nominal capacity of 320 mgd based on the conventional rating of 2 gal per min per sq ft of filter area. A plant of this capacity, with double-deck settling basins and a filtered water storage of 50,000,000 gal, required a net ground area of 20 acres. This was obtained by reclaiming land from the lake.

CONSTRUCTION IS BEGUN

The preliminary operations included the construction of a breakwater to the east of the plant site and a bulkhead enclosing a rectangular area of approximately 40 acres. On completion of the bulkhead the area within was dewatered, and construction started on the substructures. (See "Chicago Plant to Filter 320 Mgd," by Loran D. Gayton, M. Am. Soc. C.E., CIVIL ENGINEERING, April 1941, p. 229.)

By the summer of 1941 the substructures for the intake basin, low-lift pumping station, mixing and settling basins, filters and filtered water reservoir, had been completed. Suction and discharge piping for the low-lift pumps and part of the piping for the filter galleries had been purchased and was being placed. The four 100-mgd and the four 50-mgd low-lift pumps, together with their motors, had been purchased. A contract had been let for the structural steel work for the low-lift pumping station, filter building, and administration building.

The raw-water tunnel connection had been completed northward from the plant to a point near its ultimate connection with the Southwest Land Tunnel. The filtered-water tunnel connection from the plant to the Southwest



CHEMICAL BUILDING, LOOKING SOUTHEAST, AS OF FEBRUARY 1944

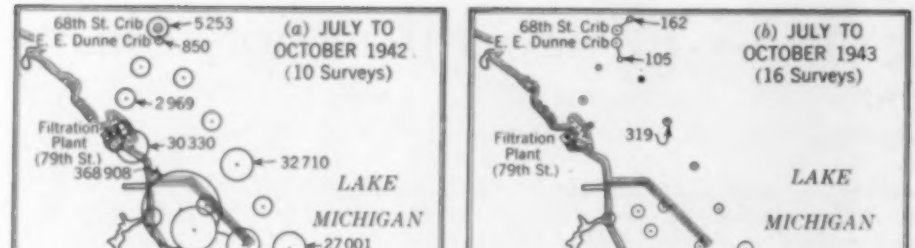


FIG. 1. COMPARISON FOR 1942 AND 1943 OF AVERAGE COLIFORM BACTERIA PER 100 CC IN LAKE MICHIGAN BETWEEN DUNNE CRIB AND INDIANA HARBOR SHIP CANAL

Land Tunnel system had also been extended northward about the same distance.

From the standpoint of estimated total cost, the plant was somewhat more than half completed. The work remaining to be done included the construction of all buildings, the furnishing and erection of all equipment other than low-lift pumps and the piping previously described, completion of tunnel connections, backfilling, grading and landscaping, and the final tuning up.

There followed a series of modifications in plans designed increasingly to reduce the amounts of critical materials. Priority applications embodying these reductions were submitted to the office of Production Management in September and December 1941, and revised schedules in January, April, and May 1942. That the reductions were substantial may be judged from the fact that critical materials aggregating some 12,400 tons originally were reduced to 7,800 tons.

Some of the items temporarily omitted were steel sash, steel doors, steel stairs and railings, passenger elevators, steel laboratory equipment, metal lath, rubber-tile flooring, through-wall flashing, valve-operating platforms, canopy over the chemical building loading platform, column guards on concrete columns, standby units, traveling cranes, and duplicate steam headers. Also omitted were heating and plumbing fixtures in all public toilets and in part of the toilet rooms designed for employees. The major change in design was the substitution of reinforced concrete for structural steel in the chemical building superstructure, whereby the amount of such steel was reduced from 1,500 to 100 tons.

In July of 1942 the city was informally advised that its request for a project priority could not be granted at that time. Having reduced the quantities of critical materials to an absolute minimum, and having acquainted the War Production Board (WPB) with the menace to public health inherent in the situation, the city saw no further course open to it.

However the failure to receive the requested priority became a matter of increasing concern during the summer of 1942. Counts of coliform bacteria in the raw water entering Dunne Crib were far in excess of counts made in similar months in any of the previous 14 years. The year 1941 had showed an alarming increase but 1942 exceeded 1941 showing a rise to 3,300 per 100 cc in August and 6,900 in September.

The criterion of 50 coliform bacteria per 100 cc average for any one month is the dividing line between Group 2 and Group 3 in the "Recommended Sanitary Requirements for Water Treatment Systems," accompanying the U.S. Public Health Service Drinking Water Standards, 1942 (*Journal* A.W.W.A., February 1943). Group 2 includes waters requiring simple chlorination or its equivalent. Group 3 includes waters requiring complete rapid sand filtration treatment, or its equivalent, together with continuous post-chlorination.

When September showed an increase over previous months, it was decided that the WPB should be advised of the increasingly bad water and again be requested to consider a project priority. At this time (October 1942) the "Recommended Sanitary Requirements" had not been published so they were not available for consideration by the WPB. However, a limitation of 50 coliform bacteria per 100 cc for lake waters capable of treatment by chlorination alone had been proposed by H. W. Streeter, M. Am. Soc. C.E., of the U.S. Public Health Service, in a paper presented before the American Water Works Association. The plea to the WPB was based on this limiting amount, and the terrifically high counts of 30,000 per 100 cc for 8 days in the months of August and September were stressed. Diagrams were introduced (Fig. 1*a*) showing the contamination of Lake Michigan at locations between Dunne Crib on the north and the Indiana Harbor Ship Canal on the south.

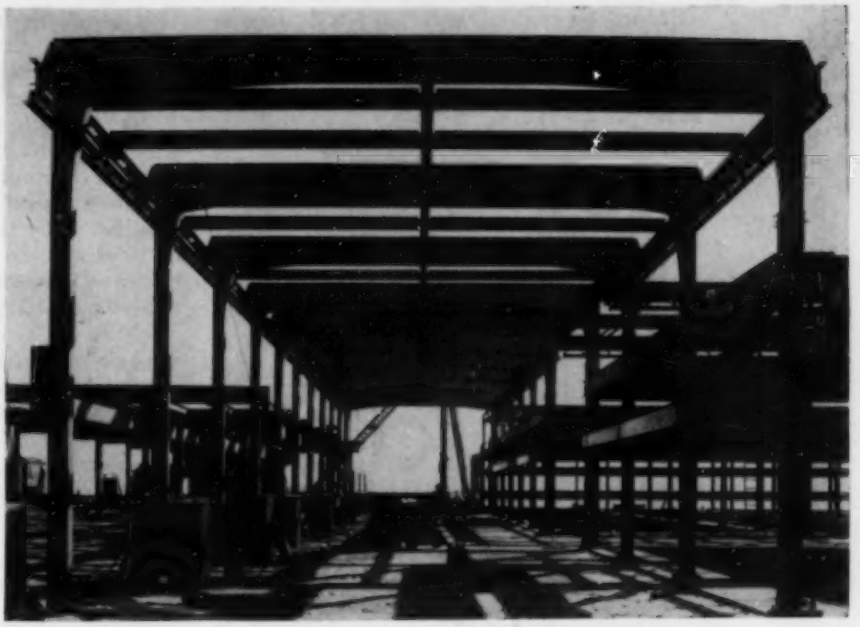
As a result, the WPB suggested the possibility of partially completing the plant in order to permit the water to be coagulated, settled, and chlorinated. It requested the city to furnish a statement of the critical materials required for this procedure, and the city agreed. But

CHLORINE ROOM IN CHEMICAL BUILDING, SHOWING CONCRETE CONSTRUCTION

city did not agree that it was possible to furnish a safe water with coagulation, sedimentation, and chlorination done.

This list when prepared showed a total of approximately 2,500 tons of critical materials. Included in the proposed work were the low-lift pumping station and chemical building superstructures; installation of the low-lift pumps already on hand; installation of most of the chemical equipment, omitting the aqua ammonia equipment, certain of the chlorinators, and dry feeders; installation of the slow and rapid mixers; and installation of the necessary electrical transformers, switch gear, feeders, and control equipment for the power and lighting requirements.

No immediate action was taken by the WPB with respect to either the entire plant or the suggested partial plant. Finally in March of 1943, a priority of AA-3 was granted on the critical materials required for the building shells of the Low-Lift Pumping Station and the Chemical Building. An AA-5 priority was granted on the service equipment required for the buildings, including plumbing, heating, and electric lighting. Plans and specifications were immediately revised to fit the granted priorities, and bids were requested on the two buildings. With most war-plant construction either finished or nearing completion, it proved an excellent time to receive bids. A total of 14 bids were received—a greater number than on any previous contract. The contract was awarded to the low bidder and these buildings are now (May 1944) under construction.



STEEL ERECTION IN GALLERY OF FILTER BUILDING IN LATE 1943

Some four months after the granting of priorities on the buildings, priorities were extended on the stripped-down equipment for them. Bids were received on chemical equipment, pumps and piping, slow and rapid mixers, traveling crane, freight elevator, and electrical equipment. All these are now under contract.

With the completion of these contracts scheduled for the late summer of 1944, partial operation of the plant will be possible. It is estimated that some 70% of the suspended matter and bacteria now in the water will be removed. The water will not be filtered, but longer contact for chlorine will be available in the 50,000,000 gal clear-water reservoir.

DIVERSION AGAIN ENTERS PICTURE

In the foregoing account of Chicago's effort, under wartime conditions, to construct a badly needed filtration plant, no mention has been made of its relation to increased diversion. Consideration of this possibility for improving the raw water has been so interwoven with the filtration plant problem as to require discussion.

Early in 1942 a report on the sanitary quality of water furnished the South District was made by L. M. Fisher of the U.S. Public Health Service. This report stressed the pollution existing in the lake water at the Dunne Crib and recommended both the completion of the filtration plant and greater diversion of lake water.

The effect of increased diversion on the quality of the raw water requires some explanation. Reference has already been made to the reversal of the natural flow of the Chicago River at the time it became a feeder to the drainage canal. By the construction of a branch channel known as the Calumet-Sag Canal, the same procedure was followed with the Calumet River.

Before its reversal, the Calumet River flowed into Lake Michigan near 91st Street (Fig. 1). Water from the lake now enters the river at that point and flows through the Calumet, the lower reaches of the Little Calumet, the Calumet-Sag Canal, and into the main channel of the drainage canal. Since the mouth of the Calumet lies between the Dunne Crib and the source of lake pollution in Indiana, the diversion of additional water from Lake Michigan by way of the Calumet would, under favorable wind conditions, remove a certain amount of polluted water from the lake.

Additional diversion through the Calumet River would also prevent reversals of the river, which occasionally result from heavy rainstorms and lowered lake levels due to wind or seiches. Such reversals carry pollution from the Calumet's two tributaries out into the lake.

Both tributaries of the Calumet rise in Indiana. The term "rise" may be misleading in that it generally indicates a difference in elevation. There is practically none along the courses of these streams. They flow parallel to each other and in a general way parallel to the southern shore of Lake Michigan. The Little Calumet is the further south and the longer. The Grand Calumet—and never was the adjective "grand" more ill-advisedly applied—traverses the cities of Gary, East Chicago, and Hammond, Ind., acquiring on the way industrial wastes, all the raw sewage from East Chicago, and effluents from sewage disposal plants at Gary and Hammond.

Although most of the sewage entering the Grand Calumet River is diverted into the Indiana Harbor Ship Canal (Fig. 1) and thence into Lake Michigan at East Chicago, some of it travels on across the Indiana state line to enter the Calumet River in Illinois. It is desirable therefore that the flow in this river should be at all times away from the lake. Increased diversion would be of service in accomplishing this result.

LEGAL AND OTHER DIFFICULTIES ENSUE

Consideration of increased diversion as one of the methods of reducing pollution in the lake water—however justifiable from the standpoint of possible results—greatly complicated the status of Chicago's appeal to

the WPB. Requiring no critical materials for its accomplishment, it seemed a most attractive experiment. Furthermore no one could predict accurately to what extent it might relieve the situation confronting Chicago, although the U.S. Public Health Service had considered it not an adequate solution and had recommended the

LAKE PORT GATES—EXTERIOR VIEW WITHIN COFFERDAM
Bottom Elevation −20, Top, −12

immediate completion of the filtration plant. The real difficulty lay in securing authority to increase diversion.

The Supreme Court, in fixing the minimum diversion at 1,500 cu ft per sec, had limited the quantity to that required for navigation. Its action on an appeal for an increased diversion, based on a question of public health, was problematical. Even assuming a favorable decision, the time required would be considerable.

In 1939, the Secretary of War had advised the Mayor of Joliet, Ill., that he was "of the opinion that the Department is without any legal authority to permit any increase in the flow of water from Lake Michigan." Relief could not be expected from this source. There remained the Congress and the President, and these in turn were appealed to. In 1942 a bill was introduced in the House of Representatives by Congressman Sabath authorizing the temporary diversion of 5,000 cu ft per sec at Chicago. This bill was referred to the Rivers and Harbors Committee of the House but no hearings on it were held during the year.

As the summer of 1943 approached, the Department of Public Works became increasingly apprehensive of the likelihood of more serious pollution in the water at the Dunne Crib than had been experienced during the summer of 1942. The WPB had not granted any priorities on equipment, and no action had been taken by the Rivers and Harbors Committee on the Sabath bill. Through the medium of the press, Chicago's Commissioner of Public Works, Oscar E. Hewitt, advised the public of the seriousness of the situation.

It was recognized that an increase in diversion offered the only possibility of immediate improvement in the water at the south end of Lake Michigan. It was also recognized that if increased diversion were to be obtained quickly it would have to come as a result of authorization by the President. Mayor Edward J. Kelly, M. Am. Soc. C.E., therefore made an appeal directly to President Roosevelt. In his reply the President suggested that if emergency diversion were required it could be resorted to, and that, "should such emergency diversion become necessary and reach amounts which threaten to leave the District without an adequate balance for the normal requirements during the remainder of the present year, the way is open for the city to apply to the Supreme Court for additional diversion."

In the meantime the Sanitary District, by careful budgeting, had increased the flow through the Calumet River over that of the previous summer. Coincident with this increase in flow from the lake, there was a marked diminution in the coliform bacteria count at the Dunne Crib intake, as shown in Table I. For the four months, June through September, the average diversion in 1943 was 3.3 times that of 1942. The average of the coliform bacteria for the same months of 1942 was 26.2 times that of 1943.

TABLE I. RELATION OF CALUMET RIVER DIVERSION AND COLIFORM BACTERIAL COUNT AT DUNNE CRIB, SUMMERS OF 1942 AND 1943

MONTH	AVERAGE DIVERSION THROUGH CALUMET, CU FT PER SEC		AVERAGE COLIFORM BACTERIA PER 100 CC AT DUNNE CRIB	
	1942	1943	1942	1943
June	265	920	218	75
July	220	1,200	156	185
August	275	940	3,310	122
September	325	550	6,907	23
Average	271	902	2,648	101

Some of the variables other than diversion which may influence the number of coliform bacteria at the Dunne Crib are wind directions and velocities; temperature of the water; lake currents; sources, amounts, and character of contamination; amount and distribution of rainfall; and trade wastes which may inhibit the growth of coliform bacteria. With such diverse factors affecting the problem, it is perhaps impossible to ascribe the improvement solely to the increased diversion. Nevertheless the comparison between the two years is of interest, as are the results of lake surveys at the southern end of Lake Michigan.

These surveys are made regularly throughout the summer months under the direction of John R. Baylis, M. Am. Soc. C.E., Engineer of Water Purification. Samples of water are taken at some 31 points between Dunne Crib and Indiana Harbor. The average of 16 surveys in 1943, Fig. 1 (*b*), showed greater pollution at the mouth of the Indiana Harbor Ship Canal than the average of the 10 surveys in 1942, Fig. 1 (*a*). This greater pollution in 1943 existed as far to the northwest as the Whiting Intake, about $1^1/_2$ miles. From that point on toward the mouth of the Calumet River and beyond, there was a marked reduction in 1943 at all sampling points. However, no sanitary engineer can thumb over the reports and charts showing the heavy pollution so close to the drinking water supply of 1,400,000 people without sharing the apprehension of those in charge of making such a water potable.

DIFFICULTIES STILL REMAIN

In September 1943, the Rivers and Harbors Committee held its initial hearing on the Sabath bill. At this hearing Chicago presented its plea for temporary additional diversion. At a second hearing the opponents of the bill voiced their objections. Following the hearing the State Department indicated that favorable action on the bill would be inimical to Canadian-American relations. There the matter rests today.

The necessity of continuing to use a dangerous raw water for the South District, the expense of an attenuated, piecemeal construction, the delay, to date, of two years in the completion of the project—all these indicate the impact of war on Chicago's South District Filtration Plant.

Concrete in Puerto Rico

Selection of Materials and Field Control

By H. K. EGGLESTON
MAJOR, CORPS OF ENGINEERS, U.S. ARMY

THE friendly climate of Puerto Rico permits the use of concrete materials and methods of placing that would be unthought of in harsher climates. An excellent grade of concrete is produced from native materials which would never pass inspection standards in the "States." The field control instituted by the Army has shown considerable direct saving in the cost of concrete while at the same time producing a much improved product with the use of available materials. Major Eggleston presented the paper from which this article was taken, at a meeting of the Puerto Rico Section.

AT MANY PLACES BEACH SAND PITS PROVIDE GOOD AGGREGATE

WHEN he first encounters the concrete aggregates and field practices commonly used in Puerto Rico, an engineer familiar with standards in the United States is surprised and disillusioned. The only fine aggregates available seem hardly suitable for curing sand, and the local batching, mixing, and placement customs cause a concrete inspector to have sleepless nights.

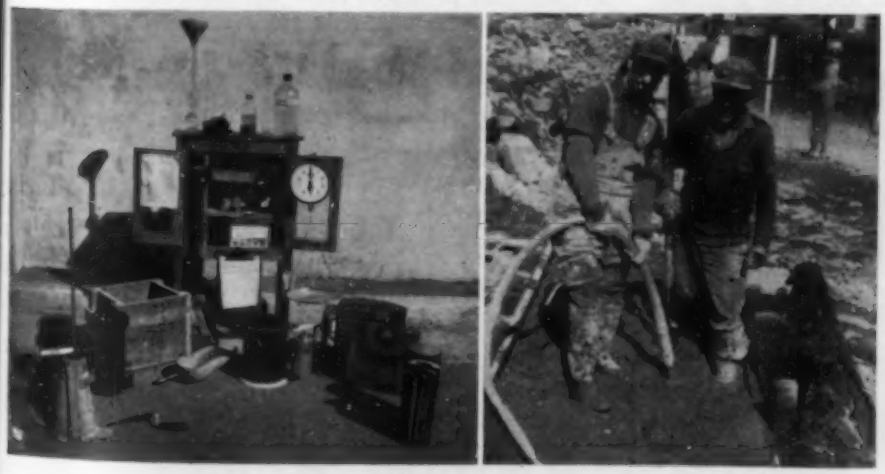
However, here the absence of frost permits a certain amount of reduction in normal standards, and the policy of the Corps of Engineers has been to modify its specifications to meet local materials and attempt to train and control local labor through the use of a concrete control unit. The problems confronting this organization have been many and varied, but through the cooperation of local contractors and foremen a superior grade of concrete has been produced on all jobs.

There are three general types of fine aggregate available in Puerto Rico—beach, river, and artificial sand. Artificial sand is secured by crushing block stone. It cannot be obtained as a by-product in the production of coarse aggregate unless special crushers and screens are provided. Therefore, use of this type of fine aggregate has been limited to U.S.E.D. projects, since local aggregate producers or contractors do not have this special equipment. The by-product of crushing operations to produce coarse aggregate, the so-called *polvillo* in Puerto Rico, has some of the characteristics of this type of fine aggregate but is deficient in sizes below No. 16 and has an excessive quantity of dust, so that it is not suitable for use alone as fine aggregate in concrete. Artificial sands are usually very harsh and unworkable, requiring more cement per yard than natural sands, and give trouble in obtaining a good finished surface, such as in floors.

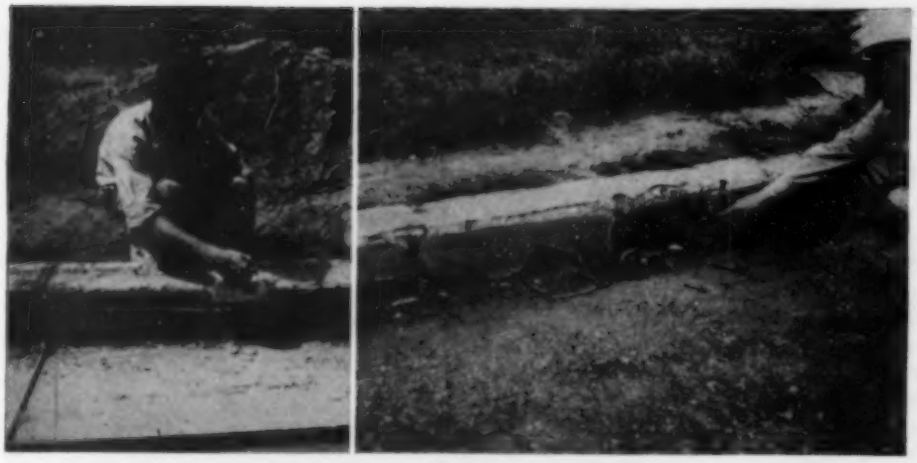
River sands are the result of weathering and grinding action, on basic metamorphic and igneous rocks, and may be composed of any of the many types of minerals present in Puerto Rico. The structural qualities of this type of fine aggregate are good, but grading is very coarse since the sand is produced in the short fast-running streams of the mountainous backbone of Puerto Rico, and grading is not improved in the meanderings through the broad sugar-producing shore areas. The beach sands may be divided into the following basic sources—shell, silica, coral, and other miscellaneous marine-life structures. The silica types are very rare on the island, and in general are only found where large rivers empty into the ocean.

At first U.S. engineers opposed the use of beach sands in concrete. However, one owner of a local beach pit persisted in his request for tests of his sand. Samples of this pit were taken and very complete tests on the material were run. Results compared very favorably with those on river sand. Further investigations have verified the fact that beach sands in Puerto Rico are as satisfactory as river sands if care is taken in selecting the proper sources. However, only one out of seven or eight beach sources will produce satisfactory sand (based on Puerto Rican standards), whereas one out of every two or three river sources will do so. Except for its low abrasion resistance and high coefficient of elasticity, which prevents its universal use, beach sand has proved to be a very satisfactory fine aggregate.

Beach sands have a natural tendency toward salt content. While it is best to have a zero salt content, the presence of this material is not as serious as might be expected. The use of sea water as a mixing agent in con-



LEFT, EQUIPMENT USED FOR FIELD CONTROL OF MATERIALS AND CONCRETE; RIGHT, VIBRATOR IN USE IN A WELL-GRADED MIX, STIFF ENOUGH TO SUPPORT A MAN



PLASTERING WITH A SAND-CEMENT MORTAR (Left) RESULTS IN SCALING (Right)

crete, or the production of a similar condition through the dissolving of the salt crystals in beach sand, is a controversial subject. Tests performed in Puerto Rico and in other laboratories show that if a structure is made of dense concrete, and if the placement is good, sea water will have no serious effect upon the quality of the concrete. Sea water has a tendency to produce higher 7-day strengths, but beyond this point strength fails to develop as fast as it would if fresh water were used. The ultimate strength of sea-water concrete may be 10% to 20% less than that of concrete made with fresh water. Owing to the location of most of the U.S.E.D. projects in this area, sea water has been extensively used in Army projects. Tests being made on specimens cast in 1940 are now substantiating the decision to use sea water rather than to bring in fresh water by barge or truck, which would have added materially to the cost.

Tests on over 500 sources of sand in this area have failed to produce a well-graded sand that will meet the grading specifications of the American Society for Testing Materials, having all sizes from No. 4 to No. 100, without wet processing of run-of-bank gravel, wasting a large percentage of the larger sizes. All beach sands and some river sands are of one sieve size, usually between 30 and 50, or 50 and 100 mesh sieves. This difficulty has been overcome in the field by blending the fine and the so-called coarse sands. Blending can best be done by providing separate stockpiles for each size on the job, so as to control the amount to be blended.

If sources of fine and coarse sand are close together, the desired quantity of the two sizes can be put on each truck used for hauling, and the sand will become mixed during unloading and batching operations. With a batching plant, it has been found that if the trucks supplying the plant are uniformly spaced to prevent the piling up of a large quantity of one size, the normal rehandling operations necessary in operating this type of batching unit will satisfactorily mix the materials. If large stockpiles of sand are built up and the trucks run up on the pile for dumping, mixing can be obtained by having two or three laborers level off each load on the pile after it is dumped. This will produce thin layers of each size and when the sand is shoveled into wheelbarrows from several locations in the pile, a fairly uniform grading will result.

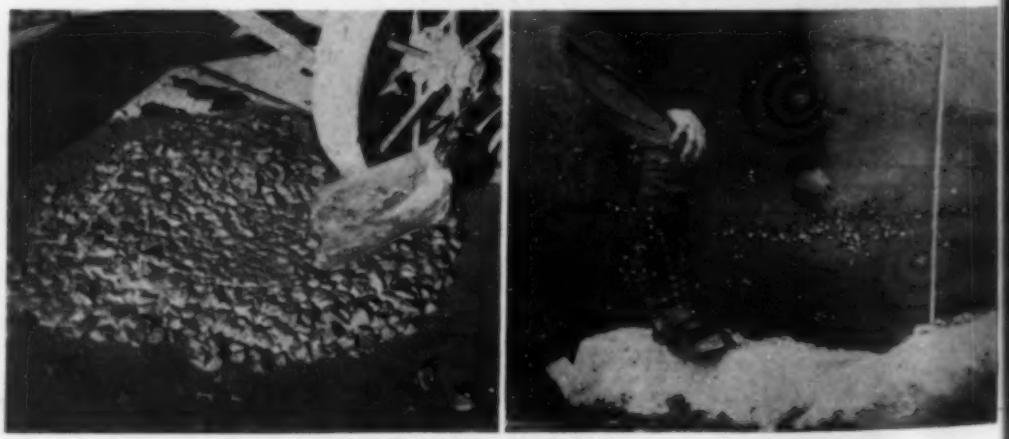
A comparison of average river and beach sands in Puerto Rico with those found in the northeastern United States may be summarized by the following statements. In general, fine aggregates in the northeastern United States will have a strength ratio of approximately 120% as compared to Ottawa sand, while those in Puerto Rico will average approximately 80%. Economy factors of continental sand are usually in excess of 100%, while 75% is a good value for materials obtained in Puerto Rico. Usually the deposits occurring in the continental United States are rather extensive and there is little or no trouble in securing uniform quality and good pit operation, such as is constantly found in the small pits operated in Puerto Rico.

FALLACY OF THE ONE-SIZE STONE THEORY

Usually an excellent quality stone quarry can be found near each project. However, local contractors and stone dealers tend to specify a one-size coarse aggregate, usually the $^1/_2$-in. or the $^3/_4$-in. size, and are inclined to complain about or reject stone that conforms to the specifications used by the War Department in this area. The usual complaint is that the War Department stone contains too much fine material and dust.

A brief consideration of the mechanics of concrete production will show the fallacy of the one-size stone theory. The design of concrete consists in filling up the voids between the stone particles with sand, and the voids between the sand particles with a cement-mortar paste. The greater the voids around the coarse aggregate, the greater the amount of sand that must be used, and the more sand used, the greater the amount of cement-mortar paste required, thus reducing economy.

Coarse aggregate, well graded from the maximum size down to the No. 4 sieve, has the minimum amount of voids and produces more workable concrete, while a one-size stone has a maximum of voids. The one-size



A MIX TO BE AVOIDED IS THIS 1-2-4, WHICH LACKS FINES AND RESULTS IN HONEYCOMBING (RIGHT)

arse aggregate will actually re-ire more cement, both from the ids angle and from that of rkability. As for the idea that ere are too many fines and dust the stone, the ideal combination sand and stone is the one that ill produce a uniformly graded aterial from the largest stone wn to the smallest sand.

The sands in Puerto Rico do t have any of the sizes normally und between No. 30 and No. or minus 100. Therefore if a niformly graded fine and coarse ggregate combination is to be btained, it is necessary to supply ese sizes from some other source. The War Department has at-empted to supply this deficiency y adding some of the crusher fines to the aggregates be-ween 1 in. and No. 4 sieve. When this material is used ith the sand, the 5 to 10% of crusher fines in the coarse ggregate, which passes the No. 4 sieve, blend with the and, and the combined aggregates approach an ideal and-stone mixture. This addition of fine material to the oarse aggregate gives the stone the appearance of aving an excess of fines, but actually the combination is f great importance in producing better workability and reater economy.

DUSTING WITH DRY SAND-CEMENT BEFORE FINISHING (Left) GIVES POOR RESULTS (Right)

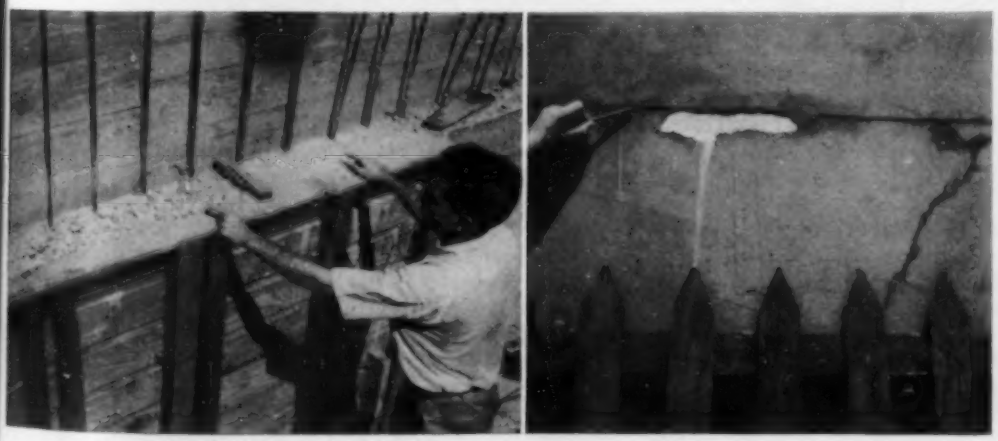
TYPES OF LOCAL CEMENT

Two types of cement are being produced in Puerto Rico. The Ponce cement is of the type having a so-called "moderate heat" of hydration, or federal specification 206*a* cement, while the Puerto Rico cement is a "standard portland," or the federal specification 191*b* type. The 206*a* cement has a greater fineness, giving greater inherent workability and is probably more resistant to the attack of sea water owing to its lower tricalcium aluminate content. This type of cement is particularly useful in massive structures, where the minimum of heat generation during hydration is important in preventing cracking, as 206*a* does not generate heat as fast as 191*b*. The strengths of the two types are comparable, and their quality compares favorably with similar types produced in the continental U.S.

In the production of high-quality concrete, a well-equipped laboratory can be of great assistance. In San Juan the War Department has set up a completely equipped laboratory which can handle practically all phases of material testing. It has a well-equipped chemical and physical laboratory; facilities for soil analysis, mix design, and aggregate testing; and special equipment for testing other products, such as asphalt and water. The laboratory has made complete analyses of over 500 sources of sand and 350 sources of stone. As a result of its work in determining the best type of materials for use, and in developing new sources of materials, it can show direct savings of over $250,000 in the past $1^1/_2$ years. It has also helped the field forces in controlling their work through mix design and testing of concrete cylinders. The laboratory has made over 30 special studies in an attempt to obtain data for fighting some of the more common bad practices in Puerto Rico.

The subject of field control is one that creates considerable controversy. The usual statement is that it is too expensive and does not give improved results. Here in Puerto Rico we were fortunate in that the same organization which had determined the materials and mix designs had control of the placement of the concrete. This double control is absolutely essential in order to make maximum effective use of the experience of men qualified in concrete control. The Concrete Section of the Engineer Department has records which show a direct saving of more than $300,000 through various types of field control. This does not include the various indirect savings, such as increased qualities, better finished surfaces, lack of cold joints, and smoother floor finishes.

Among the local bad practices which an effort has been made to correct are: (1) the tendency on small jobs to discharge the mixer before adequate mixing of concrete has taken place; (2) the plastering of concrete with a surface layer of cement-sand mortar; (3) the dusting of floor surfaces with raw cement or a dry sand-cement mixture; (4) placing of reinforcing steel in floor slabs on the ground, where it will rust; (5) omission or poor preparation of construction joints; and (6) lack of protection against rain during pouring. Some of these practices and their results are illustrated.



UNCLEANED CONSTRUCTION JOINT (Left) RESULTS IN A POOR JOINT (Right)

ONE OF SEVERAL UNITS OF THE AIRCRAFT FACTORY AT TOULOUSE
Side View of the Structure When Nearing Completion

Aircraft Factory in France Has Concrete Arch Roof

By LEON BESKIN, M. AM. SOC. C.E.
SENIOR STRESS ANALYST, VULTEE AIRCRAFT CORPORATION, ALLENTOWN, PA.

REINFORCED concrete generally cannot compete with steel for the construction of roofs with long spans. Therefore there are few examples of concrete roofed hangars or other long-span buildings in the United States. European practice has differed somewhat, and of special interest is an aircraft factory at Toulouse, France, which has an arched roof slab and reinforced concrete roof trusses. This and several similar structures were designed by Mr. Beskin during his residence in France.

REINFORCED concrete was the material chosen for the aircraft factory at Toulouse, France. This plant consists of three main buildings and several extensions. The main assembly bay has a 170-ft span and is 660 ft long. On both sides are two-story bays of 50-ft span occupied by various fabrication shops. The central bay covers an area of 112,000 sq ft, without any interior columns. The roof is composed of 20 cylindrical slabs, 2 in. thick. Each segment is 33 ft wide and sloped to accommodate skylights. The total area of windows thus provided is 40% of the floor area.

Edges and centers of the slabs are supported on 41 trusses, 16 ft 6 in. apart. These are also of reinforced concrete of light latticed construction, and interfere very little with light transmission. The trusses are required to stabilize the roof, to support the ties transmitting the horizontal component of the slab thrust, to support the wind bracing, and also to carry the track for the overhead cranes. The trusses are supported by columns which are common to the central and side bays. Three longitudinal expansion joints are provided in the side walls, each joint at the middle of a roof segment. Because of the flexibility of the roof system of the center bay, there are no joints in the roof.

Columns at the joints are split between the ground and a level somewhat below the connection with the single trusses. This design avoids conventional splitting of the column for its whole height, an arrangement which would make it necessary to use double roof trusses and a roof joint.

There are no partitions between the columns, and free access is obtained to the side bays. Both ends are closed by horizontally operating doors. The wind loads on the doors are transmitted by horizontal bracing to the columns, which are anchored by diagonals in the planes of the columns. Overhead cranes operate on four lines of track running the length of the bay and suspended at the third points of the trusses and on column haunches. Several 3-ton cranes of 55-ft span are operated on these parallel tracks.

Both the first and the second floor of the side bays were designed to provide free areas 650 by 50 ft. in which partitions can be added and removed at will. The roofs are composed of cylindrical arched slabs the full length of the bays, with three expansion joints. Thrust of the slab is carried by ties every 16 ft 6 in. These ties are supported by hangers at the third points. The second floors are of beam and slab construction with tile fillers used to decrease form work. Expansion joints correspond to those of the roof. Framing of the two-story structures at each side is designed to brace the central structure.

Main elements of the self-supporting roof are the slab, the skewbacks, the trusses, the wind bracing, and the columns. For design of the slab, reference was made to the figure of equilibrium, which is a parabola for loads uni-

ormly distributed in a lane, or a catenary for oads uniformly distri- uted along the pres- ure line. For variable oad distributions, the ressure line changes, nd if a segment of a oof slab is considered as n isolated arch, it must ave a large moment of nertia in order to be table in compression nd support the bending noments resulting from ts non-coincidence with he pressure line.

On the contrary, if closely spaced arches support the slab, it transmits in bending to the arches that part of the loads which produce a pressure line which is different from the profile of the roof slab. Such a method of transmission of loads is uneconomical, since it maintains bending for an important part of the loads, and unnecessarily loads the main trusses, which must be closely spaced. The design of self-supporting roofs eliminates bending by making use of a two-dimensional membrane of cylindrical shape. Here, the thrust at any point is a function of the normal component of the load and the radius of curvature of the line, and is generally variable along the line. That variation in thrust can agree with the tangential component of the loads, as is the case both for the parabola and the catenary described.

INTERIOR VIEW OF THE COMPLETED BUILDING

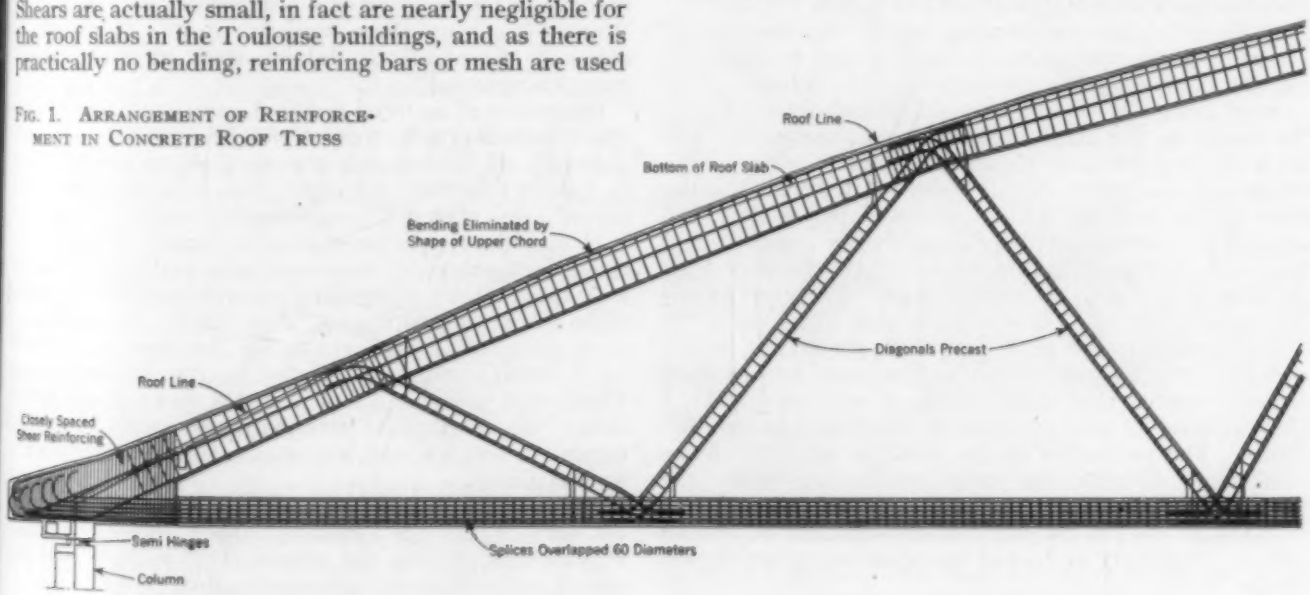
REINFORCEMENT AGAINST TEMPERATURE STRESSES

If this equilibrium between variation of thrust and tangential loads does not exist, the difference between these two quantities can be transmitted as a shear load from section to section along the arch until it reaches a structure which can absorb such a load, such as the roof trusses. Loads thus transmitted to the trusses are not perpendicular, but parallel, to the surface of the slab. Shears are actually small, in fact are nearly negligible for the roof slabs in the Toulouse buildings, and as there is practically no bending, reinforcing bars or mesh are used solely to prevent cracks due to shrinkage and temperature. Slight bending cannot be eliminated because of the difference in deflection between the slabs and the trusses when they are considered independently of one another, and the regions of the slab adjacent to the trusses have an increased thickness and additional reinforcement. An average of less than 0.8% of the area of the concrete was used for the reinforcing bars.

By thickening the slab for a width of 7 ft along the skewbacks, a beam 7 ft deep is constituted, and girders at the skewbacks are eliminated, except for a small purlin which serves as a gutter and supports the weight of one-third of the thickened slab. Owing to the width of this section, bending stresses are small in the plane of the slab, since the span (16 ft 6 in. between trusses) is less than three times the depth, and nearly all the reinforcing bars required are for diagonal transmission of shear.

Consideration of the loading on the roof trusses was not complicated by the form of the slabs, for all loads in a panel are carried directly to the supporting trusses. Actually, the slab is a part of the upper member of the

FIG. 1. ARRANGEMENT OF REINFORCEMENT IN CONCRETE ROOF TRUSS



SIDE BAYS WERE CONSTRUCTED FIRST TO GIVE LATERAL SUPPORT TO CENTRAL ROOFING SYSTEMS

truss. Since the compressive load in the slab is known, the difference between the total compressive load in the composite member and the load in the slab is transmitted by the truss member. The remaining load corresponds to the dead weight of the truss, the loads suspended from it, and secondary loads due to the action of the wind on the roof. Moreover, that part of the roof slab which is reinforced along the upper member and has the same deflections as the latter is considered as part of it, which reduces the load transmitted by the member proper. The shape of this upper chord is designed so that local bending is almost entirely eliminated.

Loads in the lattice are small, and only questions of stability and fabrication define the dimensions of the lattice, which can be pre-cast. The loads in the tie are high, and $1^1/_4$-in. bars transmit the tension. In order to eliminate secondary bending due to the dead weight of the tie, the bars are placed in the forms in the shape of catenaries. The bars are spliced by simple overlapping 60 times their diameter, without end hooks.

A detail of the construction which requires special attention is the connection at the skewback between the tie, the upper member, the slab, and the column. The general design of such a connection appears in Fig. 1. As shown on the plan, large end hooks are used. The slope at the skewbacks is such that more than half of the horizontal component of the thrust is transmitted to the bars by friction due to the vertical component. The other half is transmitted by shear in the concrete, and vertical bars, closely spaced, are required. To avoid high bending moments at the truss-column connections, semi-hinges are used.

For determining buckling in columns, lattice, upper members of the truss, and bracing, a curve derived from Euler's formula was used; this took into consideration the decrease of the modulus of elasticity under high stress. The properties of the material appear in the coefficients defining the curve, which determines the stress corresponding to instability. Beam-column formulas were used in conjunction with that curve, and an initial eccentricity of $^1/_{800}$ of the span was generally assumed.

Concrete in the structure had a minimum ultimate compressive stress of 4,500 lb per sq in. at 28 days. Copper-alloy-steel reinforcing bars were used. These had a minimum yield stress of 50,000 lb per sq in., and a minimum ultimate stress of 80,000 lb per sq in. Temperature and shrinkage reinforcing was of conventional structural grade.

FIXED FORMS PREFERRED

The contractor prefered to use fixed forms, which were stripped at the end of a 15-day period and rebuilt. Some precautions were necessary when forms were removed from under the roof slab. The operation was started at the crown, and proceeded simultaneously toward both ends, in order to set the thrust in the slab in a continuous and progressive manner. Truss forms were removed after the slab forms, and the same sequence had to be used as for the slab. It is especially important to remove temporary supports for the truss forms from the middle first, in order to avoid the temporary effect of a continuous beam on three supports in the truss, which occurs if the middle scaffolding stays after the lateral parts are removed.

Quantities of material required, per square foot of this plant, including slab, trusses, ties, bracing, columns, and generally all the concrete structure above ground, were as follows: concrete, 0.6 cu ft, that is, a uniform thickness of 7 in.; steel, 9 lb; and forms, 3.5 sq ft.

It must be remembered that in France labor is relatively inexpensive as compared with materials. Therefore, the methods of handling concrete are different from those in the United States. Apparently it would prove more economical to increase the thickness of the slab on a similar structure erected in the United States. This would increase the steel in the ties and the skewbacks, but the distance between trusses could be greatly increased, which would decrease the total amount of form work required.

Between the completion of design and the removal of the forms, a period of 5 months elapsed. A total period of $9^1/_2$ months, during the winter of 1938–1939, was required for both design and construction.

High-Level Highway Bridge Spans Thames River

IV. Erection of Superstructure

By IRVINE P. GOULD, ASSOC. M. AM. SOC. C.E.
WITH PARSONS, BRINCKERHOFF, HOGAN AND MACDONALD, NEW YORK, N.Y.

THE superstructure of the Groton–New London Bridge is nearly 6,000 ft long. It consists of girder approach spans, deck-truss spans, and a deck cantilever span over the navigation channel. Erection of this center span was complicated by the character of the river bed, which precluded the use of falsework bents. Balanced erection over the main piers is described by Mr. Gould. Previous articles in the March, April, and May issues covered preliminary planning, design, and substructure construction.

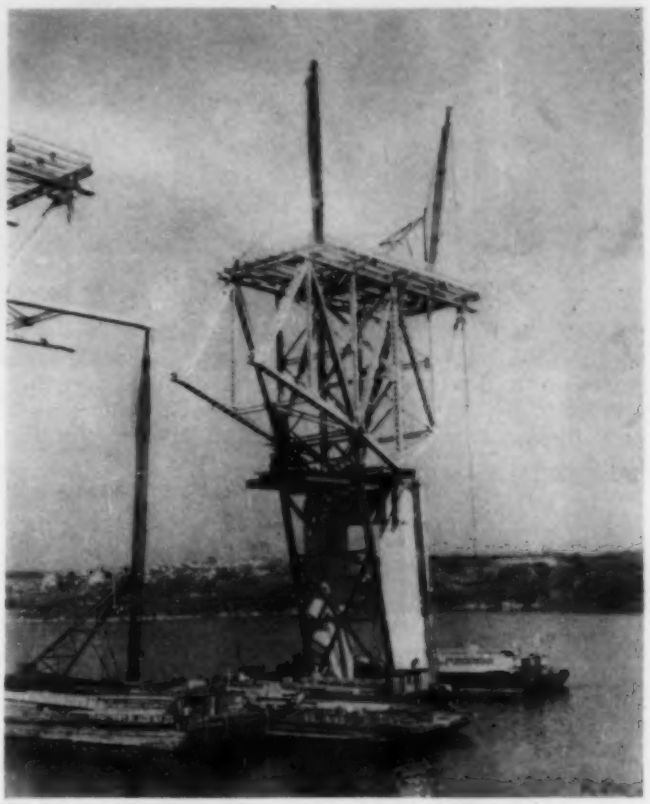
FOR the principal span of the Groton–New London Bridge over the Thames River, in Connecticut, a 540-ft deck cantilever was used. This provides a 135-ft vertical clearance over a width of 200 ft, and has anchor arms each 352 ft 6 in. long (Fig. 1). On each side of the main span are two two-span continuous deck-truss units, each span of which is 312 ft 6 in. long. These in turn are flanked by deck-girder spans extending 1,817 ft 6 in. on the west or New London approach, and similar construction for 363 ft 9 in. on the east or Groton end.

Balanced erection, that is, cantilevering of the structure in opposite directions at the same time about two fixed supports, played a major role in the erection of the truss spans. On the west side, the first of the approach deck-truss spans crosses railroad yards, so that the track clearance governed the location and number of any falsework bents required for erecting these spans. By using balanced erection methods, it was possible to reduce the number of bents and eliminate the heavy tie-downs and tie-backs that would have been necessary had these trusses been cantilevered from the adjacent girder spans. At and adjacent to the main river channel, the bed of the Thames River consists of very soft mud varying in depth from 60 to 110 ft, making the use of temporary bents supported on piles a hazardous proposition. By erecting a part of the anchor and cantilever arms in a balanced condition about the main piers, costly falsework bents of doubtful lateral stability were eliminated.

CONVENIENT MATERIAL STORAGE AVAILABLE

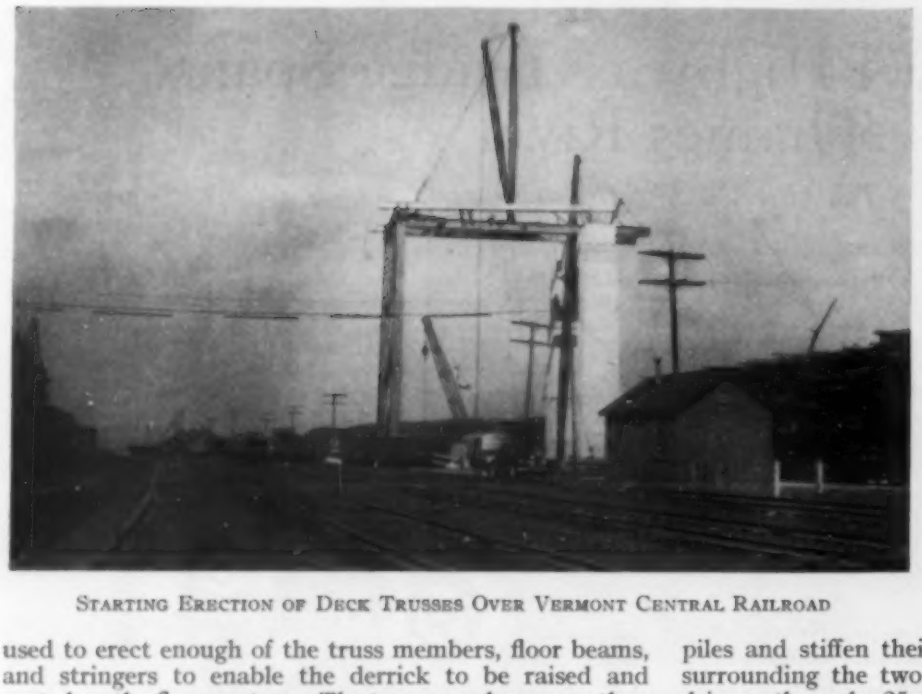
The first of the deck-truss spans on the west approach crosses the main line and railroad yards of the Central Vermont Railroad, and on the east approach the corresponding span crosses the yards of the New York, New Haven and Hartford Railroad. These yards were convenient for receiving and storing the various structural members of the trusses and for distributing them during erection. It was therefore deemed advisable that erection of the trusses should start at or near these points, but the erection method used had to be one that would permit cantilevering over the tracks.

Erection of the west approach truss spans was started at Pier 22 (See Fig. 1) by erecting a temporary bent (Bent 1 W) two panels west of this pier with a platform framing to the bent and resting on the top strut of the pier, as shown in an accompanying photograph. A guy derrick of 30-ton capacity was set on this platform and



BALANCED OVER PIER 25, ANCHOR ARM AND MAIN-SPAN CANTILEVER TAKE FORM

REVERSE JACKING DEVICE USED IN TENSION MEMBERS U_0-U_1 OF ANCHOR ARM TO MAKE CLOSURE



STARTING ERECTION OF DECK TRUSSES OVER VERMONT CENTRAL RAILROAD

used to erect enough of the truss members, floor beams, and stringers to enable the derrick to be raised and seated on the floor system. The truss members were then erected to panel points L_6 and L_{12} in such manner as to keep the structure always balanced about the bent and the pier.

Next, two travelers of 30-ton capacity, one facing east and one facing west, were erected on the deck of the structure by means of the guy derrick. Meanwhile a whirley crane erected Bent 2 W slightly east of panel point L_2. Since the location of this bent was governed by track clearances and did not come directly under a panel point, a platform was framed between the bent and Pier 21 to support panel point L_2. The travelers continued the erection of the truss in a balanced condition until the westerly part rested on the platform just mentioned and the easterly part was cantilevered to panel point L_{16}, as is shown in an accompanying photograph. When panel point L_2 had been raised to its cambered elevation by jacks provided under Bent 2 W, the platform and Bent 1 W were removed. A third bent, 3 W, was erected under L_{14} of the truss, but not supporting it, until Span 21–22 had been completed and Bent 2 W and its platform removed. Panel point L_{14} was then raised to its cambered elevation by jacks under Bent 3 W, and erection continued by the east traveler until the truss landed on Pier 23, thus completing the two-span continuous unit.

STEEL SHIPPED BY RAIL AND BARGE

Throughout these operations, and continuing during the erection of the approach deck-truss spans, the structural members were raised from the railroad yard to deck level by the guy derrick at Pier 22 and carried to the travelers on a material car running on two of the stringers. When the anchor arm and main span were reached, the steel was shipped by barge and raised directly into position by the travelers.

While the west traveler erected the girder spans of the west approach to the closure point, the east traveler continued erection beyond Pier 23, after having first set temporary pins and bolsters between the top and bottom chords of the adjoining trusses. The truss was then cantilevered eastward to panel point L_6 and landed on Bent 4 W. Each leg of this bent rested on a steel-and-timber grillage supported by 25 timber piles averaging 30 to 35 ft in length, and driven to 20-ton capacity with a double-acting steam hammer.

Instead of batter piles, the contractor elected to drive plumb piles and stiffen their tops with a 5-ft fill completely surrounding the two pile groups. Since the piles were driven through 25 ft of soft mud and fetched up with only a 3-ft penetration in the coarse sand stratum beneath, it was deemed advisable to reduce the horizontal wind shear that might be transmitted to the bent. This was done by laterally bracing the top of Bent 4 W and the truss by leaving the temporary pins in place at Pier 23, thus making the top laterals continuous over the pier. As an added safeguard, the ends of the bottom chord extending beyond L_6 were guyed to the top of Pier 24 by diagonal guys of $1^1/_2$-in. wire rope.

BOULDERS INTERFERE WITH PILE DRIVING

At Bent 5 W, in Span 24–25, the greater depth of water and a deeper mud layer containing embedded boulders and riprap seriously hampered the driving of suitable pile groups. Only 29 of the 50 piles in the bent penetrated below the river mud; the rest fetched up on the boulders and riprap. Of the latter, a majority were battered as much as 1 on 10, having been forced out of plumb by contact with the boulders and hence might "walk" under sustained static load. To stabilize the pile groups and make them act as a unit, the pile rows were tied longitudinally (parallel to the bridge axis) by angle guides, and the groups were framed together laterally by three heavy timber trusses. (See accompanying photograph.)

Two parts of 1-in. wire rope were fastened to the outer corners of the pile groups and wrapped about the diagonally opposite pier shafts; and a set of diagonal guys, in the plane of the bottom chord of the bridge, was attached to the overhanging end of the truss and the

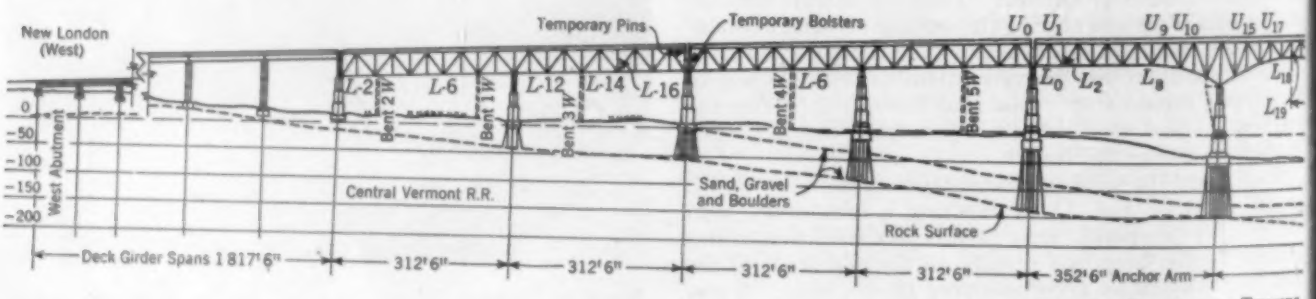
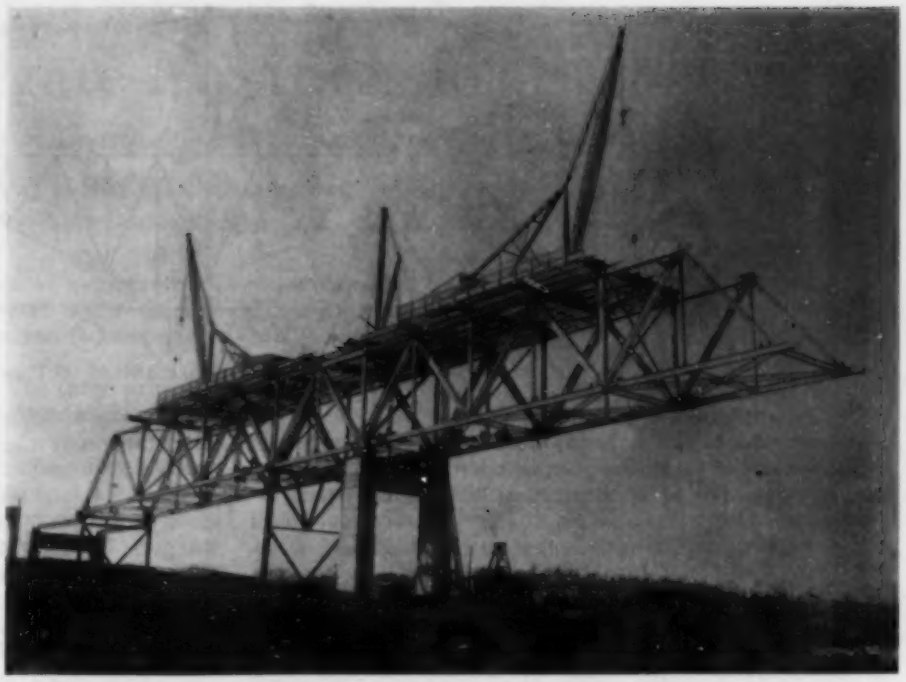


FIG. 1. PROFILE OF THAMES

pier. In addition, by controlling the elevation of the top of the bent, only as much load was permitted to come on the bent as would keep the stresses in the truss within permissible erection values. Full load on the bent thus occurred only during the time of jacking under the bent to bring the truss to camber elevation for the setting of the shoe pins at Pier 25.

For the erection of the anchor arms, considerable study was given to foundation conditions between the anchor piers and the main piers. On the New London or west side, the depth of the water varied from 12 to 25 ft, and that of the soft river mud from 80 to 110 ft. Corresponding figures on the Groton side were 22 to 30 ft of water and 25 to 90 ft of mud. It was realized that for a 15-ft penetration of the firm sand underlying this soft mud, steel piles from 120 to 140 ft long would be required to support a falsework bent. As these long piles, while they could be braced at the top and below the water line, would develop only small lateral resistance in the mud, the use of falsework bents was considered a hazardous proposition.



DECK-TRUSS SPANS WERE SUPPORTED ON TEMPORARY BENTS DURING ERECTION

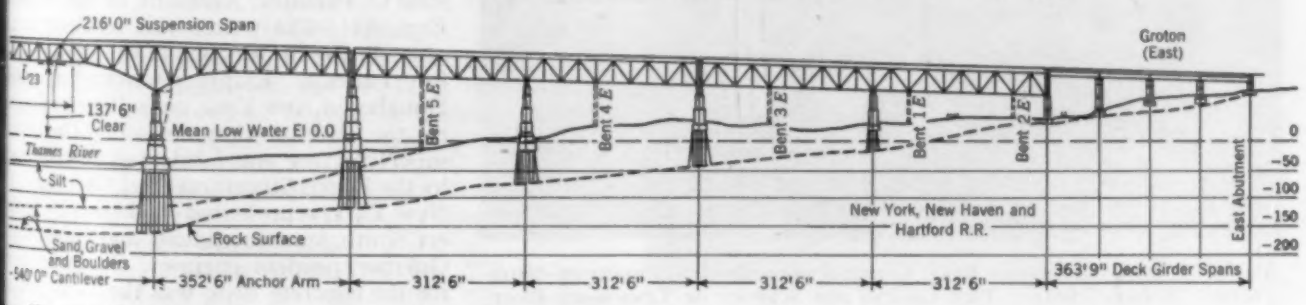
TEMPORARY BENT ANCHORED TO PIER

The alternative plan, and the one selected, was to frame a sloping bent on Pier 26, anchored in the base of the shaft and tied at the top by a horizontal strut to the main shoes, then erect the portion of the anchor and cantilever arms over the pier by maintaining a balanced condition about the pier and bent. Any unbalance during the erection sequence would produce a direct load or uplift on the bent, the amount of which would be limited by the capacity of the bent, the resistance in bending of the reinforced concrete shaft, and the stability of the pier itself. The lower section of each leg of the bent was therefore embedded in the base during the construction of the substructure and projected from the landward side of the shafts at about El. +5.2.

A platform resting on the top of the sloping bent and the pier was erected and braced to the pier shoes by pin-connected struts. A 30-ton guy derrick was then assembled on this platform. The derrick in turn erected the short vertical toggle of the bent and enough of the main truss members (numbered 1 to 8, Fig. 2), floor beams, and stringers to permit "jumping" the derrick to the deck level. The truss was then erected to panel point U_{15} (sequence shown in Fig. 2), a 30-ton capacity traveler set up at U_{15}, and erection continued by guy derrick and traveler until panel points U_9 and U_{17} had been reached and a second guy derrick set up at panel point U_{10}.

During these operations the traveler on the adjacent approach trusses had cantilevered eight panels of the anchor arm beyond Pier 25 (Fig. 2) and backed off the span. Temporary pins and bolsters were set between the chords of the trusses for continuity over the anchor pier. The remaining members of the anchor span were set by the guy derrick at U_{10}, and the closure was made with the three temporary jacking devices that had been erected with the truss members. These were located in the top chord (in member U_0-U_1), in the bottom chord (in member L_0-L_2, and acting with the temporary bolster between the trusses), and in the short vertical toggle of the temporary bent.

The first two jacking devices, when operated separately, raised or lowered the cantilevered end of the anchor arm, and when operated simultaneously moved it forward or back in a horizontal plane. The arrangement in the vertical toggle produced vertical motion at the ends of the truss erected about the main pier. The closure sequence was first to bring the holes in the lower chord connection at panel point L_8 to correct elevation by operating the jacks in member U_0-U_1 and in the vertical toggle; then to bring the holes in alinement by operating, simultaneously, the jacks in members U_0-U_1 and L_0-L_2. After this point (L_8) had been pinned and bolted, the closure in the top chord was made with the jacks in member U_0-U_1 and the vertical toggle.



VER HIGHWAY BRIDGE

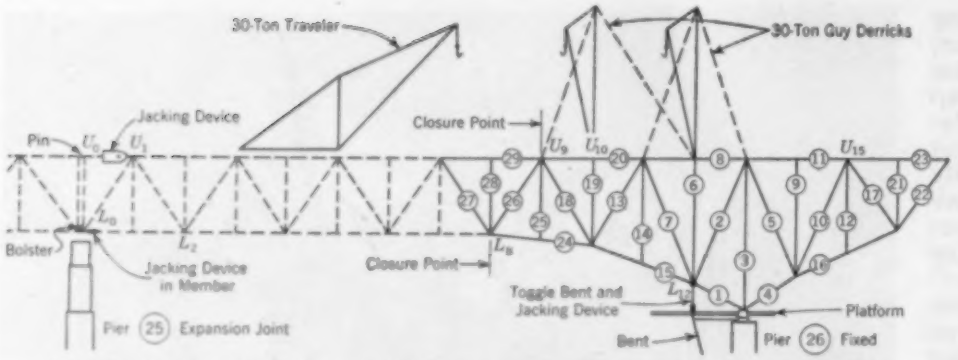
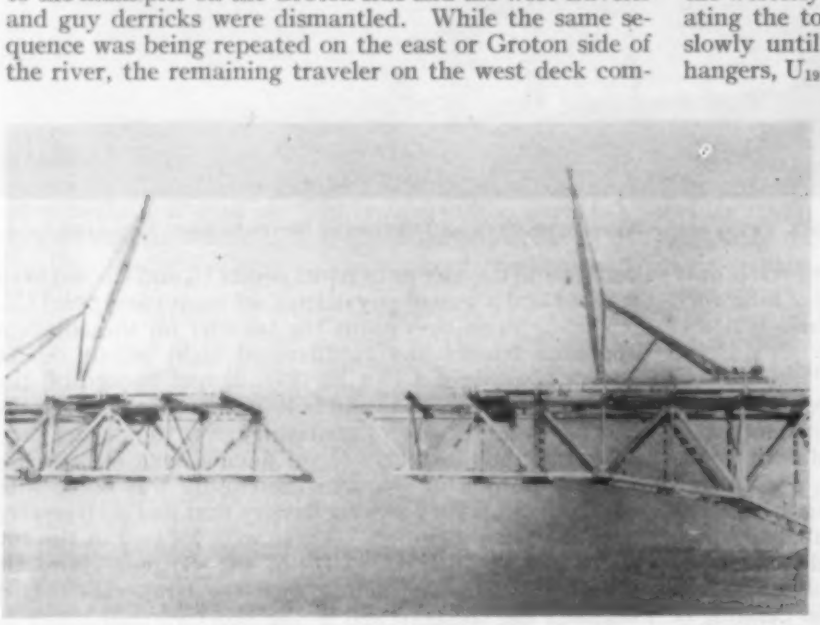
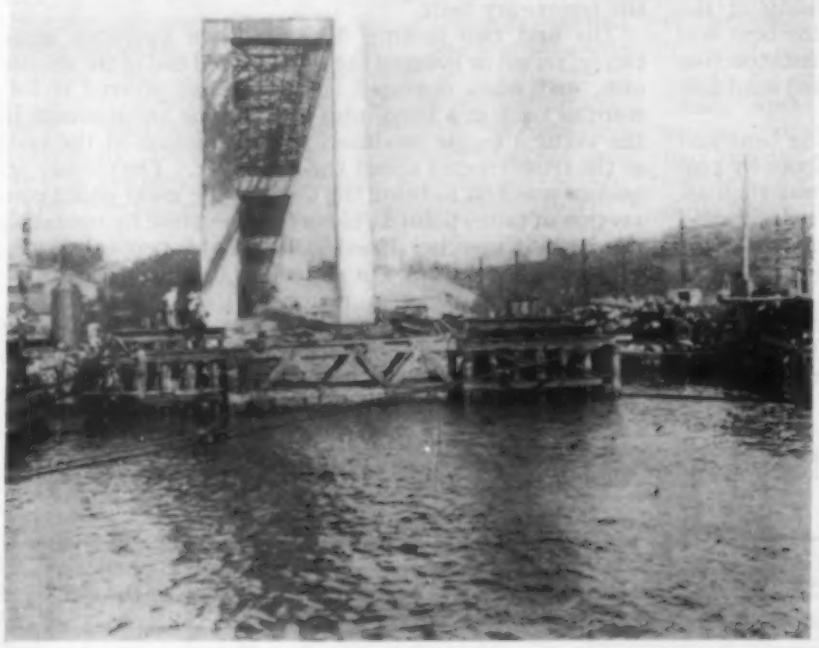


FIG. 2. PROFILE OF SECTION OF SUPERSTRUCTURE ERECTED BY BALANCING ON PIER

Upon completion of the anchor arm, the vertical toggle, temporary bent and platform were removed and shifted to the main pier on the Groton side and the west traveler and guy derricks were dismantled. While the same sequence was being repeated on the east or Groton side of the river, the remaining traveler on the west deck completed the erection of the cantilever arm and the suspended span to mid-channel (panel point L_{23}).

Jacking devices for closing the suspended span were located in the top and bottom chords of the westerly end (expansion) of the suspended span and in the top chord only of the easterly (rotation) end. After the bottom-chord closure connection at panel point L_0 had been brought to correct elevation by jacking in the top chords, the span was moved horizontally by operating simultaneously the top-chord and bottom-chord jacks at the westerly end. The top chord was then closed by operating the top-chord jacks. These jacks were released slowly until the suspended span was supported by the hangers, U_{19}-L_{19}. Identical truss layout, and comparable physical features and foundation conditions permitted the same erection sequence on the Groton side of the river.





ABOVE, CENTER SUSPENDED SPAN CANTILEVERED DURING ERECTION—NOTE JACKING DEVICES; BELOW, PILE GROUPS FOR SUPPORT OF TEMPORARY BENT TRUSSED AND GUYED FOR LATERAL STABILITY

It should be pointed out that the continuous and cantilever trusses called for in the design readily lend themselves to the erection methods chosen by the contractor and made it possible to start the balanced erection and take full advantage of cantilevering methods at points in the structure where the cross-sectional area of the members was the greatest. All members were thoroughly checked for stresses induced by erection, and it was found that the only members requiring additional cross-sectional area for the erection stresses were the end top-chord members of the approach trusses where cantilevering was adopted, the end top and bottom chord members of the approach trusses and anchor arms at the pier from which the anchor arm was cantilevered, and the top and bottom chord (dummy) members between the suspended span and the cantilever arms.

The bridge was constructed for the Groton–New London Bridge Commission from the design, and under the supervision of the Connecticut State Highway Department, for which William J. Cox, M. Am. Soc. C.E., is Commissioner. In charge of the work for the Highway Department was A. W. Bushell, M. Am. Soc. C.E., Deputy Commissioner. Field supervision was under the direction of W. G. Brenneke, M. Am. Soc. C.E., Project Engineer, and Paul C. Parshley, Assistant to the Project Engineer. The writer was resident engineer, during the erection of the truss spans, for Parsons, Klapp, Brinckerhoff and Douglas, of New York, consulting engineers to the Bridge Commission. The steel superstructure was fabricated and erected by the Harris Structural Steel Company, of New York, represented on the job by Robert Smith, superintendent, and Edward L. Guerber, resident engineer. Subcontractor for the concrete deck was the A. I. Savin Construction Co. of Hartford, Conn.

Soil Aggregate Mixtures for Stability

Review of Current Methods in Construction and Control for Roads and Airport Runways

By ROY W. CRUM, M. AM. SOC. C.E.

DIRECTOR, HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, WASHINGTON, D.C.

SIMPLY stated, soil stabilization is a method for adding granular material to fine soils, or fine material to granular soils, in such proportions that the resulting mixture will "stay put" under the conditions of use for which it is designed. The three principal uses are for (1) stabilized surfaces, (2) base stabilization, and (3) subgrade treatments.

Stabilized surfaces are used because not many natural soils will carry heavy and fast-moving traffic in all weather without special treatment or surfacing. They are muddy and slippery in wet weather, dusty in dry weather, rough and rutty in the winter, and bottomless in the spring when the frost goes out. Paving is the obvious remedy, but still for many highways conventional pavements are not economically feasible. These roads, to produce all-weather service, must be treated in some way to render them stable under all, or most, climatic conditions. Stabilization by means of soil-aggregate mixtures is one type of treatment for this purpose.

Base stabilization is fundamental. Almost any type of road or runway surface will give a good account of itself if it rests on a foundation that will stay in place throughout the year. But soils underneath pavements may swell, or shrink, or be displaced with fluctuations in water content, frost, and character of traffic. Not many soils in the natural state will furnish stable support; hence in most cases it is necessary either to build a rigid surface that will perform satisfactorily irrespective of the underlying support (if that is possible), or to provide an adequate transitional layer. Flexible-type pavements require stabilized transitional layers not only to guard against the vagaries of the supporting soil, but to furnish structural strength.

Subgrade treatment of some sort is often needed under rigid-type pavements to prevent the bad effects of unstable soil support, and often a further subgrade treatment is necessary in the case of a flexible pavement on a stabilized base. To meet these conditions, considerable difference in the composition of mixtures for surfaces and bases is required. Subgrades require mixtures similar to those for bases, but much more latitude may be permitted in the combinations.

The ruling factors in producing stabilized soil-aggregate layers are the characteristics of materials, material combinations, and degree of compaction secured in processing.

MATERIALS

Soil, although a term that is used somewhat loosely, is, however, largely self-explanatory. It is the layer of earthy material on which a road or runway is built. For our purpose, it is divided into two fractions by the 200-mesh sieve.

Aggregate is any material in the stabilized mixture which is retained on the No. 200 sieve. Usually part of the aggregate comes with the soil.

Fine soil, the fraction passing the No. 200 sieve, is further subdivided into silt and clay. The coarser grains, or silt, are distinguished by grittiness. The finer non-gritty particles compose the clay; they become cohesive when wet to form a sticky mud.

Controlling characteristics of granular materials are particle size, gradation, and the binding properties of the fine-soil fraction. Gradation is determined by sieve analysis, and binding properties are measured by the tests for liquid and plastic limits.

Sieve analysis is used to determine gradation in sizes. This test is important because stability and resistance to shear and abrasion depend largely upon the interlocking of particles larger than those passing the No. 200 sieve. A large body of experience has been used to establish the desirable limits of sizes. The method of making sieve analysis has been standardized by both the American Society for Testing Materials and the American Association of State Highway Officials, as follows: A.S.T.M., "Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregate," C136-39; and A.A.S.H.O., "Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregate," T27-42.

Liquid limit is the percentage of water at which a soil passes from the solid or plastic state to the fluid state. Water can be present (1) as a film adhering to the surfaces of the particles, (2) as capillary water, or (3) as free water. The liquid limit is reached when the total water content becomes large enough for free water to be present. Below this limit materials capable of holding capillary water are plastic and above it they are fluid. Materials, such as coarse sand, that do not have spaces of capillary size are not plastic, although they may hold water in the film phase. A high liquid limit indicates that the material will hold large amounts of film and capillary water owing to the presence of fine particles with large total surface area and capillary-size voids. This condition tends toward instability and sponginess. Liquid limit is determined from that part of the air-dried sample which passes the No. 40 sieve. It is defined by moisture content, expressed as a percentage by weight of the oven-dry soil, at which the soil will just begin to flow when jarred slightly. That is,

COMPACTION BY MULTIPLE-TIRED ROLLER

LIQUID LIMIT TEST, USING MECHANICAL DEVICE
Standard Grooving Tool Shown in Front

soils at the liquid limit have a very small but definite shear resistance which may be overcome by the application of little force. At the liquid limit the cohesion is practically zero.

The soil sample containing a previously determined percentage of water is placed in a porcelain evaporating dish about 4½ in. in diameter, shaped into a smooth layer about ⅜ in. thick at the center, and divided into two portions by means of a grooving tool of standard dimensions. The dish is held firmly in one hand and tapped lightly 10 times against the heel of the other hand. If the lower edges of the two soil portions do not flow together, the moisture content is below the liquid limit. The test is repeated with more or less moisture, as the case may be, until the two edges meet exactly after 10 blows.

A mechanical device, calibrated against this hand method, is used in most laboratories. The liquid limits obtained by an operator of average experience and skill, using both methods, should check closely for identical soil samples. The standard methods of test for the liquid limit of soils are: A.S.T.M., D423-39; and A.A.S.H.O., T39-38.

Plastic limit, also determined on the fraction passing the No. 40 sieve, indicates the other end of the range in moisture from the liquid limit, within which the binder material has plastic properties. It is defined by the lowest moisture content, expressed as a percentage by weight of the oven-dry soil, at which the soil can be rolled into threads ⅛ in. in diameter without breaking into pieces. Soil that cannot be rolled into threads at any moisture content is considered non-plastic.

The plastic limit is therefore the moisture content at which cohesive soils pass from the semisolid to the plastic state. It is also the moisture content at which the coefficient of permeability of homogeneous clays becomes practically zero. The standard methods of test for the plastic limit of soils are: A.S.T.M., D424-39; and A.A.S.H.O., T90-38.

Plasticity index is the difference between the liquid limit and the plastic limit, or the range of moisture content through which the soil is plastic. When the plastic limit is equal to, or greater than, the liquid limit, the plasticity index is reported as zero. When the plastic limit cannot be determined, the plasticity index may be designated by the letters NP (non-plastic) to indicate that the soil is entirely lacking in plasticity.

This index is a measure of the cohesiveness of the material and of its flowability under pressure. A low index indicates low cohesiveness, and a high index, a tendency to instability when wet. The value desired is the one between these two extremes that will best meet the conditions of use, whether for surfaces, bases, or subbases.

MIXTURES AND COMPACTION REQUIRED

The basic theory for soil-aggregate stabilization is that properly composed and graded mixtures will bear wheel traffic when in a damp condition, much of the stability being furnished by the adhesive power of the thin films of water surrounding each particle of aggregate, silt, or clay. Problems arise when it is attempted to retain these moisture films against the vagaries of the weather. When it rains, the penetration of water must be resisted and the lower stability, due to excess water, must be compensated for by the interlock of particles. In dry times, means must be found to retain the moisture films or provide other types of adhesive films. Soil-cement and bituminous mixtures are extensively used for this purpose, but the scope of this paper does not permit a discussion of them.

For surface courses to be used without bituminous cover, maximum stability is provided by dense, fine-textured, well-compacted mixtures having sufficient capillarity to insure the retention of water. An excess of water does not occur in mixtures of such high capillarity because the water brought to the top by capillary attraction evaporates if unrestrained. But with a water-tight cover, trouble will result when the capillary water comes up beneath this lid and finds no place to go; the clay may swell and soften to a disastrous extent. Hence, for bases, maximum stability requires a well-compacted mixture with slightly lower capillary properties, and a more open-textured grading of particles. Thus base courses require different mixtures from surfaces; and if a road with a stabilized course designed for use as a surface is to be improved by adding an impervious wearing course it is necessary to tear up the stabilized layer and revamp it, except in those cases, defined in the standard specifications of the A.S.T.M. and the A.A.S.H.O., where the original mixture might be considered suitable for either type of use.

Below the stabilized surface course or base course just discussed, comes the foundation. It frequently needs some stabilization treatment, by means of subbase

ORDINARY SHEEPSFOOT ROLLER IS USEFUL FOR CONSOLIDATION

r blanket layers, to aid it in resisting the vertical pressures of the loads without excessive deformation and to prevent detrimental volume changes due to climatic variations and moisture fluctuations. A wide range of mixtures and treatments has been used for this purpose. For all purposes, maximum compaction is an essential feature of the stabilization process.

TREATMENT OF SURFACE COURSES

The criteria for successful stabilized surfaces are: (1) particle-size grading that will provide abrasive resistance and shear strength by interlocking of particles; (2) a binder soil content that will provide cohesion and resistance to penetration of water; (3) maximum compaction; and (4) protection against surface disintegration in dry weather.

Particle-size gradations that are known to produce satisfactory results for stabilized surfaces may be found in the A.S.T.M.'s Tentative Specifications for Materials for Stabilized Surface Course, D557-40T; and in the A.A.S.H.O.'s Standard Specifications for Materials for Stabilized Surface Course, M61-42.

Cohesion and resistance to penetration of water are provided principally by the clay part of the fine-soil fraction. The significant characteristics are determined by the tests for liquid and plastic limits. According to the specifications for surfacing mixtures just noted, the liquid limit must be not more than 35, and the plasticity index not less than 4 or greater than 9.

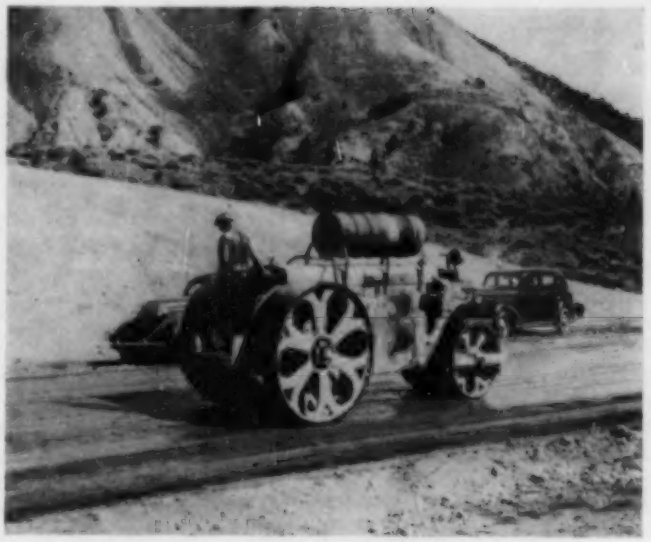
Sodium chloride and the chlorides of calcium and magnesium are frequently used with the type of soil-aggregate mixtures under discussion. The chlorides of calcium and magnesium are deliquescent, that is, they have the property of dissolving in water drawn from the air. Hence, they have a powerful effect on the retention of water films in the interior, and they also facilitate compaction. At least 10 lb per ton of stabilized mixture, as an admixture, should be used for these purposes.

Sodium chloride, although not deliquescent, has the property of attracting and retaining water, and so adds to the property of water retention in the capillary pores.

OPERATION OF COMPACTION TEST IN LABORATORY

It also crystallizes in the pores near the surface, thus retarding evaporation, which is advantageous, except when high capillarity is combined with a very wet underlying condition.

Compaction to the greatest extent possible is an essential requirement. The degree depends upon the amount of moisture in the mix and upon the compacting operation. The amount of water which will be conducive to maximum compaction varies with the character of the soil. A satisfactory procedure for predetermining this



THREE-WHEEL ROLLER PREPARING SURFACE COURSE

is to compact samples of the mixture with various water contents in a mold. No compaction-test method has been standardized. One procedure, recommended in the Wartime Road Problem Bulletin No. 5 of the Highway Research Board, on Granular Stabilized Roads, is to use the weight per cubic foot of the compacted sample as the measure of compaction.

Having determined the optimum amount of water, the adequacy of the rolling operation can be checked by determining the weight per cubic foot of undisturbed samples taken from the road or runway after rolling. A satisfactory test method for "Determining Density of Soil Layer," is described in *Public Roads* for February 1942. According to E. A. Willis (*Public Roads*, November 1939), the presence of calcium chloride in the mix is conducive to adequate compaction with much less rolling than the presence of water alone.

Surface protection in dry weather is another need. The best means so far used for alleviating dust on untreated stabilized surfaces is to apply about 1 lb per sq yd of calcium chloride when the surface is damp from sprinkling or natural causes. Since this salt has the property of penetrating the mass, the treatment has the further desirable effect of helping to maintain the moisture in the interior of the layer.

BASE-COURSE STABILIZATION

The significant features of stabilized base-course construction are: (1) grading to provide adequate particle interlock; (2) binder soil content sufficiently cohesive for stability, but with low enough capillarity so that an excessive amount of moisture will not cause trouble; and (3) maximum compaction.

Grading and cohesion requirements are covered by the A.S.T.M.'s Tentative Specifications for Materials for Stabilized Base Course, D556-40T; and by the A.A.S.H.O.'s Standard Specifications for Materials for Stabilized Base Course, M56-42. For cohesion they require that the fraction passing the No. 40 sieve shall have liquid limits and plasticity indices not greater than 25 and 6, respectively, for Type A (sand-clay mortar), and Type B (coarse-graded aggregate) mixtures; and values not greater than 25 and 3, respectively, for Type C (screening or sand).

Compaction to a high degree is also necessary for stable bases. Best results are secured when placement of the cover course is delayed for a seasoning period and

PRE-MIXED MATERIAL DUMPED IN WINDROWS BEING SPREAD AND LEVELED BY A GRADER

to take advantage of the further consolidating action of traffic. Trouble is likely to result if a bituminous surface is placed on a granular stabilized layer, no matter how well compacted, if most of the water used in rolling is still present. About 40% of this water should have gone before the top is applied.

Calcium chloride in the mixture (about 10 lb per ton) can be used advantageously in this process. This salt facilitates the compacting operation and thus shortens the necessary seasoning period.

TO STABILIZE THE SUBBASE

In cases where the natural subgrade soil does not have sufficient bearing power, or is susceptible to detrimental volume change due to climatic variations and fluctuations in water content, it is desirable to introduce another stabilization layer to form a subbase. The functions of this layer are less complex than those of surface and base courses, and considerable latitude in its composition is permissible. Practice recommended by the Highway Research Board in Wartime Road Problems, Bulletin No. 5, is as follows:

> (*a*) For drainage layers or substitute blankets, to the depth affected by frost, for naturally silty soils which become unstable due to frost or subsequent thaw, use non-plastic granular material with not more than 8% passing the No. 200 sieve.
> (*b*) For subbase on soils of low support and treatments on plastic soils (plasticity index more than 15) which are subject to detrimental volume change, use
>
> > (1) non-plastic granular material with not more than 8% passing the No. 200 sieve; or (2) materials having more than 55% between the No. 10 and No. 200 sieves, with a maximum liquid limit of 35, and a maximum plasticity index of 15; or (3) in locations not subject to detrimental frost, any material with a maximum liquid limit of 40 and plasticity index not greater than 1/4 the liquid limit.

Use of the specifications quoted should insure stability under rather extreme climatic and unfavorable moisture conditions. It is not to be inferred, however, that such precise control is always necessary. One of the best features of stabilization practice today is that it permits of wide variation with satisfactory results, when the design is not dictated by extreme conditions.

The standard specifications may be regarded as one of two guides to be used in particular cases. The other is previous experience with the materials locally available for use under prevailing conditions. After all, the problem is that of making the best use of such materials to secure a satisfactory result. The possibility of economical departures from the standards, as indicated by experience in the same locality, or with similar conditions and materials, should never be overlooked.

The common problem is to find some material nearby which can be added to the subgrade soil to produce the needed stability. Less frequently, it will be found desirable to haul and place another material which, without further treatment, is known to have the wanted characteristics, or to mix materials and haul them to the site from a central plant.

Preliminary studies may be facilitated by manual examination. Wartime Road Problems No. 5 on Granular Stabilized Roads, of the Highway Research Board, has the following to say on simple field observations:

> If a sample of well-graded material, with particles coarser than about 1/4 in. excluded, is wetted and squeezed in the hand, the following characteristics will be noted: (*a*) The soil is extremely gritty; (*b*) it can be formed into definite shapes that retain their forms even when dried; (*c*) if the clay alone adheres to the hands, it will only be enough to discolor them slightly; (*d*) if more than enough soil to discolor the hands adheres to them, it will consist of both sand and clay instead of clay alone; and (*e*) when the wetted sample is patted in the palm of the hand it will compact into a dense cake that cannot be penetrated readily with a blunt stick the size of a lead pencil; (*f*) if the wetted sample is compacted into a container and allowed to dry, it will show little or no shrinkage.
>
> The grittiness of the sample indicates the presence of sufficient granular material. Development of some strength on drying indicates a sufficient amount of binder soil. Resistance to the penetration of the pencil or stick, even when the sample is thoroughly wetted, indicates desirable interlocking of the grains and the presence of a sufficient amount of capillary force.
>
> Too much sand would cause the sample to fall apart when dried. Too much clay would leave the hand muddy after the wet sample was squeezed, and would cause the wet sample after being patted to offer little resistance to the penetration of the stick, and would cause excessive shrinkage of the sample on drying.

For determining the best proportions, the simplest procedure is to make and test trial mixes until one is found that has the necessary characteristics. In most cases the final decision will probably be reached on the basis of such trial mixes. The process may be shortened by making some preliminary educated guesses. Having sieve analyses of the separate materials, it is of course easy to compute the sieve analysis of any predetermined combinations. To compute how much of each material to use to get a combined analysis within a fixed range is not quite so easy, but methods for so doing have been devised. Henry Aaron (*Proceedings*, Highway Research Board, Vol. 21, p. 515, 1941), has proposed a simple graphical solution. A mathematical one, used by the Michigan State Highway Department, is given in the Highway Research Board's Bulletin No. 5.

Predicting the plastic properties resulting from combinations of materials is not so certain. A method used by the Michigan State Highway Department, given in the *Proceedings* of the Highway Research Board just mentioned (p. 311) has been found effective in connection with final trial mixes.

For this review many publications have been consulted. Acknowledgment is particularly due to numerous articles in *Public Roads*, to the standard specifications and test methods of the American Society for Testing Materials and the American Association of State Highway Officials, and the Wartime Road Problem Bulletin of the Highway Research Board on Granular Stabilized Roads. Photographs of tests and applications are included by courtesy of the Public Roads Administration.

Development of Commercial Explosives

By E. L. THAYER

TECHNICAL SERVICE SECTION, E. I. DU PONT DE NEMOURS AND COMPANY, WILMINGTON, DEL.

AT this time the mention of explosives brings to mind a recent raid over Hitler-held territory, when 500 tons or so of explosives were dumped on appropriate targets. No "newscaster," relating the bombing, mentioned that an equal amount of commercial high explosives was used the same day in mines and quarries and on construction jobs in the United States. Over one million pounds of dynamite are used every day by our basic industries. This paper by Mr. Thayer was presented before the Metropolitan Section of the Society.

THERE are two broad classifications of explosives today—commercial and military. The former includes black blasting powder and dynamite, and the latter, smokeless powder, nitrocotton, trinitrotoluene, and many others. Neither class can be substituted in any great volume for the other. Black powder is too weak for modern military use, and gives off such volumes of black smoke that it would expose our positions to the enemy. Dynamite is too sensitive and powerful for use in guns or shells; and also it is too prone to explode on the impact of a bullet to be safely transported in combat areas.

On the other hand, military explosives are too expensive for commercial use, as modern ammunition requires refinements and uniformity in manufacture that could not be justified in explosives for mining and quarrying. Some are also weaker than many dynamites and give off such large quantities of toxic gases that they could not be used underground. Military explosives cannot be made in commercial explosives plants or vice versa, and it is not economically possible to convert either plant to manufacture the other type of explosive.

The early history of explosives and their actual invention is a matter of much speculation. Gunpowder is certainly the oldest variety, and while great antiquity has been conferred upon it, and it has been linked with "Greek fire," it is doubtful if potassium nitrate of sufficient purity was known before the Middle Ages. The Chinese and Arabians knew of saltpeter about 1250 to 1300, and they used it in fireworks for military purposes. Roger Bacon's writings contain undoubted reference to gunpowder, instructions for its manufacture being concealed in ciphers. He was well acquainted with the fact that it exploded violently when ignited in confinement. Very little progress in the development of gunpowder took place until it was used to propel missiles from guns, and this invention appears to be due to a German monk, Berthold Schwartz, who is also generally considered the inventor of firearms. Old manuscripts record different dates for this discovery, but guns were certainly in use by 1320, and gunpowder was used for undermining fortifications soon after 1400.

POWDER ASSUMES A PEACEFUL ROLE

It appears that gunpowder was used only as a military explosive for at least 300 years, and it was not until the early part of the seventeenth century that it was adapted to the peaceful arts of mining and construction. The first authentic documentary evidence states that Kaspar Weindl used gunpowder in the royal mines of Shemnitz, Hungary, in 1627. The growth of this practice was retarded by the lack of proper drilling equipment, the necessity of developing a new mining technic, and the high cost of the explosive. However by 1650 gunpowder was being utilized in mining in Germany, Saxony, and Sweden. Records show that nearly 5 tons were used in the Freiberg Saxony district in 1675.

The composition of black powder varied widely until about 1650, when it became fairly well established at approximately 75% saltpeter, 15% charcoal, and 10% sulfur, a formula which is not materially different from the one in use today. The high cost of potassium nitrate held up the widespread use of this explosive in rock work until 1857, when Lammot duPont successfully replaced this expensive ingredient with the cheaper Chilean saltpeter, or sodium nitrate. This new formula quickly replaced the old potassium nitrate black powder for all except a few specialized uses, and it is the well-known black blasting powder of today. Our mines use over 150,000 lb every working day.

The next era in the history of explosives was heralded by the discovery of nitroglycerin by Sobrero in Italy, and nitrocellulose by Schoenbein in Germany in the year 1846. These proved to be extremely violent explosives and much more powerful than black powder. Attempts to use them commercially met with unexpected difficulties and many disastrous explosions. Furthermore, while a spark or a flame had been a very satisfactory means of igniting black powder, they were entirely inadequate for either of these new explosives.

STONE PROPERLY BROKEN UP BY EXPLOSIVES CAN BE EASILY HANDLED BY EQUIPMENT

QUARRY BLAST BREAKS LOOSE THOUSANDS OF TONS OF STONE

A Swedish chemist, Alfred Nobel, obtained a British patent for a fulminate of mercury blasting cap in 1867. His discovery that nitroglycerin could be consistently and completely detonated by mercury fulminate is one of the greatest advances in explosives science, as it opened the way to the practical use of all high explosives.

DISCOVERY OF DYNAMITE

The practice of blasting with nitroglycerin was hampered by its extreme sensitiveness to shocks and jars and by the fact that, being liquid, it was of practical use only in holes pointed downward. In 1867, Nobel discovered that kieselguhr, a chalky earth, would absorb about three times its own weight of nitroglycerin. This mixture of 75% nitroglycerin and 25% kieselguhr gave a reasonably plastic material that was much less sensitive to shock than the liquid nitroglycerin, could be conveniently transported and handled, and efficiently detonated with a blasting cap. This was called Nobel's Dynamite No. 1.

With his chemical background, Nobel soon realized that the inert kieselguhr added nothing to the chemical reactions involved in the explosion of nitroglycerin; in fact it detracted from it as it absorbed heat. He substituted sawdust and wood pulp, which would be consumed in the explosion and later added potassium nitrate or sodium nitrate, which furnished oxygen for combustion. These mixtures of nitroglycerin, sodium nitrate, and wood pulp are the straight dynamites of today. There is little demand for them now as chemical research has produced dynamites that are cheaper, less dangerous to handle, and better suited to underground and wet work. However, they still serve as the standard for determining the strength of all modern dynamites.

European chemists had been studying nitrocellulose as a military explosive ever since its discovery. Nobel looked at it from the blasting angle and in 1875 patented blasting gelatin, a plastic rubber-like explosive made by adding 7 to 10% of nitrocotton directly to nitroglycerin. It is still made on practically the same formula and sold under the same name. It will retain full efficiency almost indefinitely under water. Nobel also discovered that much smaller percentages of nitrocotton gave a thinner gelatinized nitroglycerin, which imparted remarkable water resistance to dynamites. He patented those mixtures of nitroglycerin, small amounts of nitrocotton, pulp and sodium nitrate, which are sold today as straight gelatins.

Ammonium nitrate will explode with considerable violence if properly primed with, for instance, nitroglycerin. Therefore it was logical to replace part of the nitroglycerin in dynamites with this chemical, as the resulting mixture would be just as strong but less dangerous to handle, and cheaper. This change instituted the long line of very popular ammonia dynamites, which are widely used today in mines and quarries. As ammonium nitrate is very hygroscopic, the use of these dynamites was confined to dry work for many years; however chemical research has recently added considerable water resistance to certain grades, thus widening their field of usefulness.

Naturally, ammonium nitrate was also substituted for part of the nitroglycerin in straight gelatin to form the well-known family of ammonia gelatins. As their water resistance is only slightly less than that of the straight gelatins, they have replaced the latter grade in all except the most severe work.

AMMONIA DYNAMITES USED IN MINES

Black powder was the preferred explosive for coal mining because of its slow heaving action. However, it gave a hot flame of long duration when it exploded and was the cause of many terrible coal-mine disasters when shot in the presence of coal dust or gas. Attempts to shoot coal with straight dynamites showed that this explosive was just as dangerous and entirely unsuited in properties for the purpose. Ammonia dynamites were slower in action and gave flames that were cooler and of much shorter duration than black powder. Early in this century, the U.S. Bureau of Mines and the explosives manufacturers went to work to develop a safety explosive for coal mines, and in 1907 the first permissible dynamite for use in gaseous and dusty mines was announced. This was the forerunner of a long line of dynamites manufactured expressly for coal mining. There are now 180 on the approved list. They are designed to meet every possible coal-mining condition, and are mostly low-density (that is, high stick count) ammonium nitrate dynamites, although there are also a fair number of gelatinous and water-resistant permissibles. It is gratifying to note that since their introduction there has been not a single instance of a coal-mine explosion involving properly used permissible dynamites. Their use has increased steadily, and last year coal mining consumed over 90 million lb of permissibles, or 21.5% of the entire consumption of the country. They have not entirely displaced black powder, as some 55 million lb of the latter was used in 1943, but the quantity is gradually decreasing.

The ammonia permissibles were purposely made very low in density, that is, with as high a cartridge count as possible, in order to approach the low strength and slow action of black powder and avoid undue shattering of the coal. Their success in coal shooting indicated that similar dynamites might work well in soft ores and rocks that are easily broken. Field trials showed this to be true,

and a series of low-density ammonium nitrate dynamites were developed which have found wide use in lead, zinc, and limestone mines. They are characterized by low nitroglycerin and high ammonium nitrate contents, so that they are very strong per unit of weight. However, they are so bulky and run so many more cartridges per case than the regular ammonia dynamites that they are much more economical where the work is dry.

For many years, gelatins designed for very wet work had to be used even when conditions were only moderately wet or damp. As far as ability to withstand water was concerned, there was nothing between the highly water-resistant gelatins and the non-water resistant ammonia dynamites until chemical research produced the semi-gelatins. These grades are about half-way between the types just mentioned, as they will detonate at full efficiency after several hours of exposure to water. They are fairly high in stick count, so that they can usually be substituted for gelatins with economy when water conditions are not too severe.

SPLENDID RESULTS ARE OBTAINED IN COAL MINES BY PROPER CHOICE OF EXPLOSIVES

The freezing point of nitroglycerin is about 54 F, so all dynamites formerly froze if exposed for any length of time to low temperatures. They were then insensitive and had to be thawed before use. This operation was very dangerous and resulted in numerous accidents every winter. About 1920 to 1923 the explosives chemists were able to eliminate this fault by adding freezing-point depressants which act like the substances used to protect automobile radiators. The most common low-freezing ingredients are trinitrotoluene, dinitrotoluene, glycol, diglycerin, and sugar. All dynamites manufactured by reputable explosive manufacturers today will withstand any temperature met in this country without freezing. This is the greatest single development in explosives manufacture in recent times, as it entirely eliminates the hazardous operation of thawing dynamite.

Exposure to water pressures in excess of 40 to 50 ft will frequently cause gelatin to detonate at reduced efficiency or even to fail altogether. Straight dynamite will withstand heads up to 75 ft, but it is undesirably sensitive, and much submarine work, especially in the field of seismic exploration, must be done under extreme depths of water. The research chemists took up this problem and designed a type of gelatin that will explode at full efficiency under several hundred feet of water. These grades have been widely accepted by the oil companies for seismic exploration and should be of great value in all submarine work.

The most recent development in the commercial explosives field is "Nitramon," which is classed as a blasting agent as it is not an explosive in the usual sense of the word. It consists essentially of ammonium nitrate and cannot be detonated by fire, blows, shocks, friction, rifle bullets, a commercial blasting cap, or Primacord. It requires a special trinitrotoluene primer to explode it at full efficiency. Although it has been on the market less than ten years and has been limited by its characteristics to certain types of quarries and the seismographic trade, it has been well received. It represents the greatest advance in safety in blasting since the discovery of low-freezing dynamite, and we hope that some day our chemists will tell us how to adapt it to all kinds of blasting.

TOXIC GASES

About 60% of all the dynamite consumed, or some 250 million lb per year, is used underground, where fumes are of the greatest importance. Intense chemical research both in the field and in the laboratory has developed formulas that give an absolute minimum of toxic gases in the products of combustion. Gelatins and semi-gelatins head the list in this respect, with certain ammonium nitrate dynamites close behind. The enormous quantities used underground prove that the formulas were well designed. However, all dynamites produce some toxic gases, and adequate ventilation is still a vital necessity in all underground blasting.

From Nobel's Dynamite No. 1, blasting gelatin and straight gelatin, chemical research has developed well over 100 different grades of dynamite to fit every type and condition of blasting. In 1943 coal mining used over 148 million lb, construction work 82 million lb, metal mining 105 million, and quarrying and non-metallic mining 85 million—a total of over 420 million lb produced by 15 manufacturers in 34 plants distributed over the entire country. In addition to this, over 55 million lb of black powder were consumed. The major portion of this immense volume was transported over the railroads, and their record is worth repeating. In the past fifteen years, the railways of this country have transported between 4 and 5 billion lb of commercial explosives without a single fatality or lost-time accident attributable to this cargo. This is certainly evidence that these dangerous materials can be handled safely if strict attention is paid to safety rules. The same statement applies to their manufacture and use. We must never forget that all explosives are made to explode; that is the only reason for their existence. They must be treated with respect at all times and places.

Observatory Records Reveal Magnetic Storms

Stations Established to Measure the Earth's Magnetic Field Aid in Retracing Old Boundary Lines

By J. H. Nelson

Observer in Charge, Tucson Magnetic Observatory, U.S. Coast and Geodetic Survey, Tucson, Ariz.

BOTH strength and direction of the earth's magnetic field vary. So that surveyors may rely upon field observations of magnetic directions, a constant record of these variations must be maintained. Continuous recordings and periodic "absolute" observations are made by the U.S. Coast and Geodetic Survey at the Survey's "magnetic observatories," using highly sensitive magnetographs. The equipment and its use are described by Mr. Nelson in this paper originally presented before a meeting of the Arizona Section of the Society.

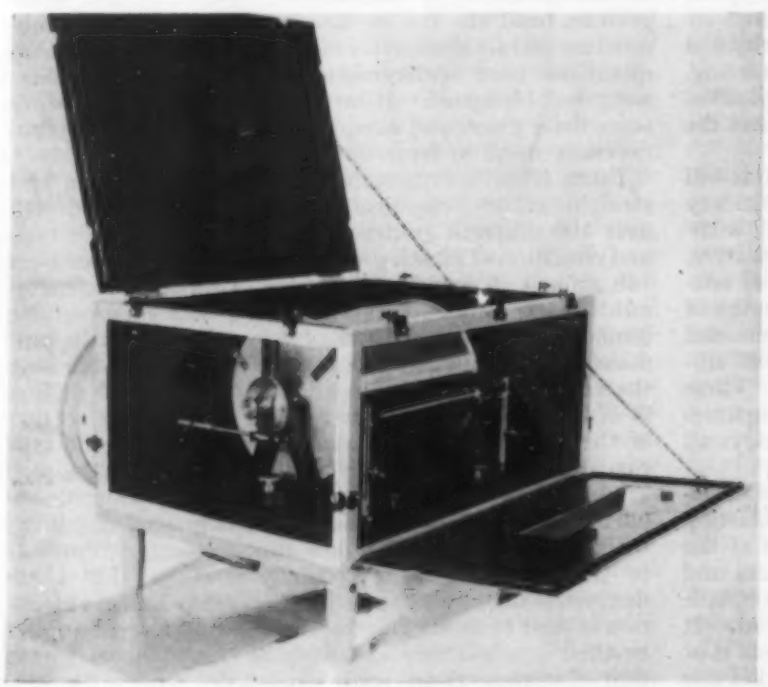
THE question most frequently asked by visitors to the Tucson (Arizona) Magnetic Observatory, in prewar days when such visits were encouraged, was "What is a magnetic observatory?" A magnetic observatory may be described as a scientific laboratory equipped with instruments for measuring the strength and direction of the earth's magnetic field and for obtaining a continuous record of the changes that occur in that field.

There are a number of uses for this information, both practical and scientific. An accurate knowledge of the changes that have taken place in the magnetic declination over a period of years, in some places amounting to several degrees, is useful both to public surveyors and to private engineers in recovering and reestablishing old boundary lines originally established by compass. Unfortunately these changes cannot be predicted. Not only are they irregular with respect to time, but the pattern of changing declination over the country is itself subject to irregular and unpredictable changes. Field observations made at thousands of places in the United States furnish information for nautical and aeronautical navigation charts and for other magnetic charts that are published periodically. The magnetic observatories serve as control stations, or base stations, for the field observations.

Knowledge of the disturbances that occur in the earth's field is used in evaluating the results of geophysical prospecting surveys that are based on magnetic methods. Studies have been, and are being, made on the correlation between disturbances in the earth's field and disturbances in radio and telegraph communication work, and on the relation between the earth's field and such phenomena as sunspots and auroral displays.

In order to describe completely the earth's magnetic field at an observatory it would be sufficient to know at every instant of time the magnitude of the vertical component and of two perpendicular horizontal components of that field. It is more common, however, to record the Z (vertical intensity), the H (maximum horizontal intensity), and the D (declination, or direction of H) components. In order to fulfil the requirement that these components be known at every instant of time, a continuous record is made of their changing values.

Except in a very few places, a compass does not point to the north magnetic pole. It is customary to think of the geographical meridians of longitude as straight north-south lines. For this reason perhaps many people think of the compass as an indicator of the direction of similar straight lines, or magnetic meridians, passing through the magnetic poles. The compass does indicate the direction of the magnetic meridian at the point where the compass is, but the magnetic meridians are not straight lines. Their curves are determined and affected by many kinds of geological formations containing rock or ore whose magnetic properties, even though slight, serve to distort what might otherwise be a comparatively smooth, evenly distributed magnetic field. There are many places where the earth's field is so distorted that a compass is practically useless; in some places in the United States the values of declination at two points only a few miles apart differ by 20° or more.



Recorder Opened to Show Revolving Drum Which Holds the Photosensitive Recording Chart

If a short bar of completely de-magnetized, hard steel, equipped with a pair of pivots or knife edges, is balanced horizontally, and then magnetized, one end becomes depressed. This is the north-seeking end or north pole of the magnet (in the northern hemisphere). There is an equal and opposite force pushing up the south pole of the magnet, however, so that the new position of the bar is the result of the application of a torque rather than of a single force. Thus the bar tends to be drawn into the direction of the earth's field, which in the vicinity of Tucson makes an angle of about 60° with the horizontal.

Now, if the magnet is rebalanced by grinding off a little of the steel at the lower end, it assumes a new position dictated by the action of two opposing torques—one due to magnetic forces and the other due to gravity—since the center of gravity of the bar has been moved

away from the vertical plane of the two pivots by grinding. The force of gravity, as far as the magnetic instruments are concerned, is a constant; therefore, if a change takes place in the magnetic force, the position of the magnet changes, through a slight tipping, until the torque due to gravity is again equal to the magnetic torque. The two ends of the magnet are at very nearly the same elevation; therefore, the effect of changes in the horizontal component of the field is second-order (causing only a slight change of sensitivity of the balanced magnet), and only the variation of torque due to a change of Z is effective in moving the magnet appreciably.

Thus the balanced magnet, if provided with a means of measuring its movements, becomes a "vertical component magnetic variometer," or Z variometer. The magnet of the Z variometer at Tucson is about 5 c (centimeters) long, weighs something like 5 grams, and has a magnetic moment of the order of 50 c-gram-sec units. It is equipped with two knife edges and an optically flat mirror 10 mm in diameter—and the whole assembly (magnet, knife edges, and mirror) is cut, ground, and polished from one piece of magnet steel. The two knife edges rest on highly polished saddles of agate, and the magnet operates in a vacuum. Its sensitivity is such that it would respond measurably to the addition of a mass of one ten-millionth of a gram to one of its ends.

In one respect the H variometer is like the Z variometer—it balances a magnetic torque against a mechanical one, but its mechanical construction is entirely different. At Tucson the H magnet is a small round rod of magnet steel 10 mm long and 2 mm in diameter, with a magnetic moment of about 8 c-gram-sec units. The magnet is mounted in a small stirrup, which also carries the necessary mirror, and the stirrup is suspended on a fused quartz fiber about 6 in. long. The mirror in this case is a piece of optically flat glass with a coating of aluminum sputtered on its front surface.

When suspended on a twist-free fiber, the magnet will of course seek a magnetic north-south direction. The magnet is forced into a magnetic east-west direction, however, by twisting the upper end of the fiber at the time of installation. The two torques then acting on the magnet are the magnetic torque due to the horizontal component of the field, and the mechanical torque transmitted through the fiber. The Z component cannot, of course, affect the position of the magnet because of the type of suspension used; nor can a horizontal east-west component affect the H magnet, for an east-west line through one end of the magnet passes also through the other end, and the resulting torque is zero. This means, of course, that the H variometer is not appreciably responsive to changes in declination.

In construction, the D variometer is quite similar to the H variometer, except that no attempt is made to balance opposing torques. The magnet is suspended from a very fine quartz fiber (about 0.01 mm in diameter, as compared with about 0.08 mm for the H fiber), and all twist is removed from the fiber so that the magnet will not be urged out of the magnetic meridian.

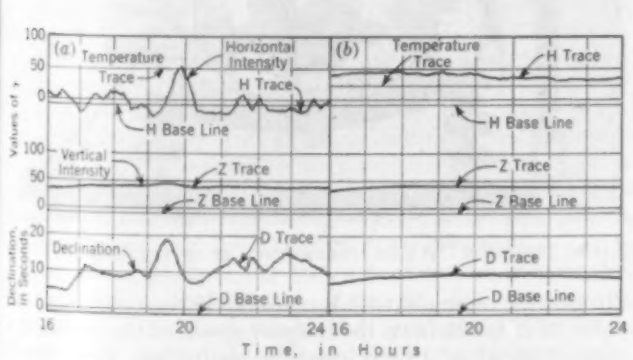
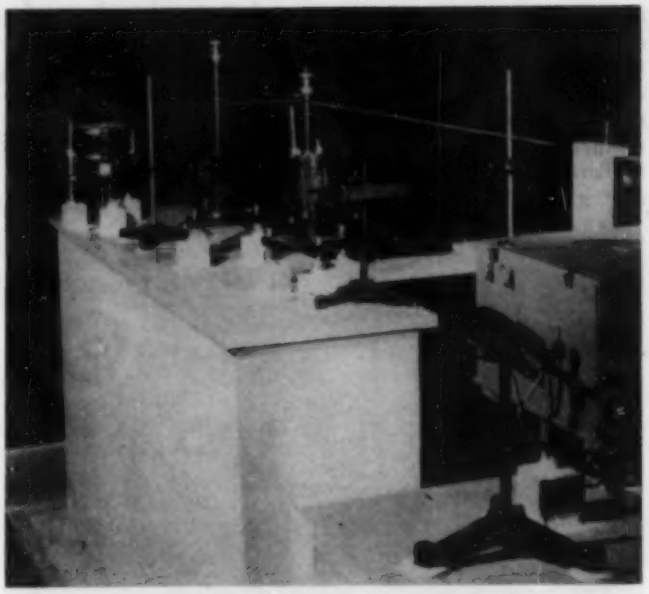


FIG. 1. SECTIONS OF TYPICAL MAGNETOGRAMS
(*a*) For a Magnetic Storm, and (*b*) For a Quiet Period



THE MAGNETOGRAPH, AN ASSEMBLY OF PRECISE INSTRUMENTS
From Left to Right Are the Z Variometer, Temperature Indicator, D Variometer, and H Variometer, All of Which Focus Their Light Beams on the Recorder at Extreme Right

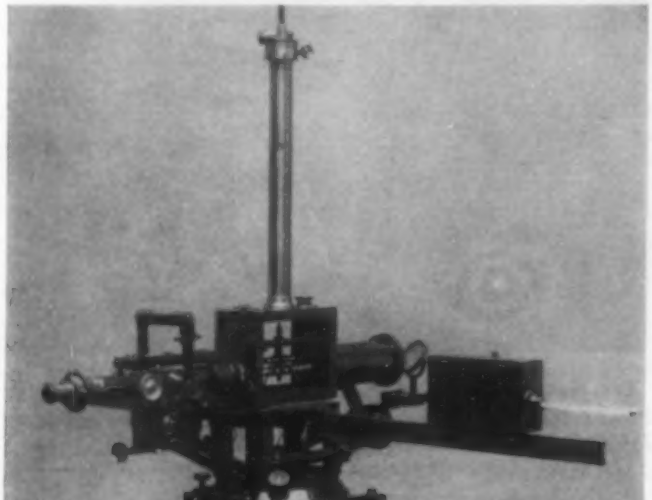
MAGNETIC STORMS RECORDED

The Z, H, and D variometers, together with the source of light (a straight-filament, battery-operated lamp) and a rotating drum that carries the photographic paper, make up a magnetograph. The variometers and recorder assembly are equipped with suitable mirrors, lenses, and prisms so that beams of light reflected from the moving mirrors are focused to fine points at the surface of the slowly moving photographic paper on the recording drum. The resulting record is a magnetogram, Fig. 1. Timing lines, controlled by an accurate clock, are flashed across the magnetogram once each hour.

At Tucson the magnitude of the horizontal component of the earth's field is about 0.26 c-gram-sec unit, or 26,000 gammas. A severe magnetic storm at Tucson would show a range of possibly 500 γ in H and $1\frac{1}{2}°$ in D. In more northern latitudes the disturbance in the earth's field during magnetic storms is much more intense. A range of 2,500 γ in H has been recorded as far south as the Cheltenham (Maryland) magnetic observatory. In the magnetic polar regions, D varies through large angles during storms—a complete change of 180° in direction would not be out of the question. Disturbances in Z are ordinarily somewhat less intense than those in H. Magnetic storms themselves are not perceptible to the human senses—they have no connection with local meteorological disturbances such as thunderstorms.

To prevent the transmission of vibrations from the building to the instruments, the magnetograph is mounted on piers separate from the building foundations. It is desirable to reduce the temperature gradients to a minimum, and for this reason the magnetograph room is thermally insulated with a 4-ft layer of sawdust on all sides and on top. Much of the mineral insulating wool commercially available is unsuitable because it contains traces of magnetic material. The floor of the room

at Tucson is about 8 ft below the ground level; at that depth, the earth itself provides sufficient thermal protection for the floor. During part of the year it is quite common for the outdoor temperature to have a daily range in excess of 20 C, but the range inside the building is rarely more than $^1/_4$ C in 24 hours. The unique feature of the building is its construction entirely without any iron or steel. All nails, hardware, and reinforcing



MAGNETOMETER MOUNTED TO MEASURE HORIZONTAL INTENSITY

materials are of copper, brass, bronze, or aluminum alloys; where door hinges and locks contained steel parts, these were replaced with brass or bronze pieces.

The location of the observatory is important—it must be sufficiently isolated to eliminate the possibility of disturbance by artificial magnetic fields or by mechanical jarring. Highways should be at least a quarter of a mile away, railroads at least a mile. Buildings, water tanks, and pipe lines (including underground pipes) should be 300 yd or more distant, depending upon the amount of steel in them. Electric railways, including street-car lines, have been known to have an appreciable effect at a distance of several miles because of the large direct currents used.

Certain parts of the magnetograph have been called variometers because they are instruments for detecting and indicating variations in the earth's field. They will not, however, give any measurement of the absolute values of various components of the field, and therefore they must be calibrated or compared with a standard set of absolute instruments, this comparison usually being done once a week. The absolute instruments are the magnetometer for measuring the strength and direction of the horizontal component of the field, and the earth inductor for determining the true angle of dip of the field in relation to a horizontal plane.

The simplest operation with the magnetometer is that of measuring declination. A hollow cylindrical steel magnet is suspended from a fine gold fiber inside a small wooden box that protects the magnet from air currents and rapid temperature changes. This box, or magnet house, is mounted with a small telescope on a horizontal theodolite circle. The magnet itself is equipped with a collimating lens and cross hairs so that the direction which the magnet assumes under the urging of the earth's field may be quite accurately observed with the telescope. Changes of declination of 10 sec of arc are readily detected. By comparing the direction which the magnet assumes with the known azimuth of a distant mark, also observed through the telescope, values of D are measured. Then by reference to the position of the D trace on the magnetogram at the time D was observed with the magnetometer, the D variometer can be calibrated.

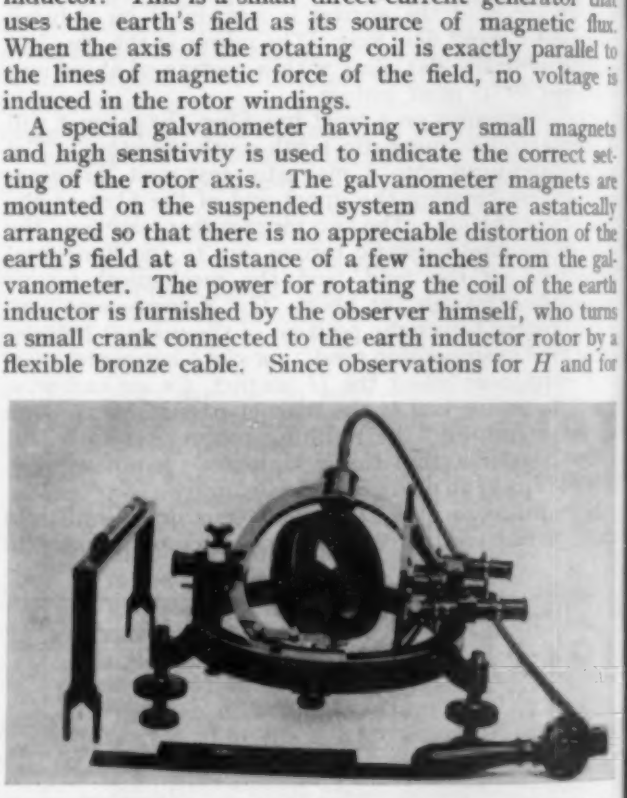
The method of Gauss, involving two operations known as "oscillations" and "deflections," is used in measuring the intensity of the horizontal component. A magnet suspended on a fine gold fiber, is allowed to oscillate under the influence of the magnetic field, and its period of oscillation is accurately timed. The period will be shorter, of course, for higher values of H. Then the same magnet is used as a deflector, and its effect in distorting the earth's field, as indicated by a suspended auxiliary magnet, is observed; this effect is also a function of H. From the two kinds of data so obtained, the absolute value of H is derived and may be used in calibrating the H variometer.

It is not easy to measure directly the vertical component of the earth's field with an absolute instrument, although it has been done experimentally. The usual method of obtaining values of Z is to measure H and the angle of dip of the earth's field. Then

$$Z = H \tan I$$

where I is the dip (angle of inclination). Dip may be measured by observing the position assumed by a mechanically balanced, magnetized dip needle mounted on suitable bearings. Because of the mechanical imperfections of even the best dip needles, however, a much more accurate determination can be made by using an earth inductor. This is a small direct-current generator that uses the earth's field as its source of magnetic flux. When the axis of the rotating coil is exactly parallel to the lines of magnetic force of the field, no voltage is induced in the rotor windings.

A special galvanometer having very small magnets and high sensitivity is used to indicate the correct setting of the rotor axis. The galvanometer magnets are mounted on the suspended system and are astatically arranged so that there is no appreciable distortion of the earth's field at a distance of a few inches from the galvanometer. The power for rotating the coil of the earth inductor is furnished by the observer himself, who turns a small crank connected to the earth inductor rotor by a flexible bronze cable. Since observations for H and for



EARTH INDUCTOR USED TO DETERMINE DIP OF THE EARTH'S FIELD

dip cannot be made simultaneously by one observer, the value of H taken from the magnetogram at the time of the measurement of dip is used in computing the vertical intensity Z. This computed Z is a calibrating value for the recorded Z trace.

Engineers' Notebook

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

The San Dimas Water-Stage Transmitter

By E. A. COLMAN *and* E. L. HAMILTON

ASSISTANT FORESTER AND ASSOCIATE SILVICULTURIST, RESPECTIVELY, CALIFORNIA FOREST AND RANGE EXPERIMENT STATION, FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE, GLENDORA, CALIF.

IN hydrologic research there are certain purposes for which measurement of rate of water flow may be more significant than measurement of total flow during a storm. The successful interpretation of rainfall-runoff relations in terms of infiltration rates is one example of the value of this kind of analysis.

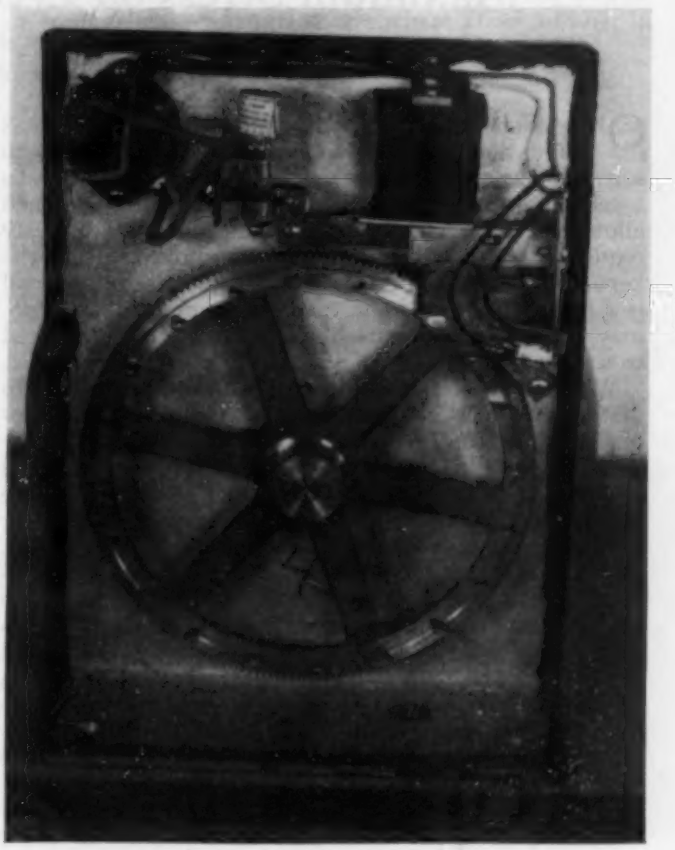
Satisfactory instruments have been devised for recording precipitation and stream-flow rates. Precipitation measurements involve small quantities of water, while in stream-flow measurement the volumes passing the measuring point are relatively very large. Between these two extremes lies the whole field of sample-plot runoff measurements, for which tipping buckets of various sizes and designs have been generally used. These function well for the low rates of flow at which they are calibrated, but they are inaccurate in the measurement of large variable flows. Weirs have sometimes been used, but they are inaccurate for small flows. Usually water flow from runoff plots and lysimeters is collected in tanks. Water stage recorders can be mounted on the tanks to record the rate of inflow, but since there are usually numerous repetitions of these installations, the cost of a battery of water stage recorders would be great and the confined time scale might be inadequate for the recording of rapid flow rates.

The lysimeter installations on the San Dimas Experimental Forest required synchronized measurements of the rate of water flow into 50 tanks. Operation of the installation would be simplified and essential synchronization of the records would be effected if 10 or more of those records could be made on a single chart. It was decided to use strip-chart time or operation recorders having 20 independent, electrically activated pens, each pen to be operated by a water-level transmitting instrument mounted on a lysimeter catchment tank. No transmitters were available which combined rugged mechanism, reliability, and low price. To meet these requirements members of the San Dimas staff designed a transmitter, and the authors modified and improved it to develop the instrument now in use.

The San Dimas water stage transmitter is a float-operated instrument and is therefore not subject to time lag caused by varying rates of water flow. The maximum rate that can be measured depends upon the speed of the recorder, but a wide range is insured by the use of separate single- and 10-counting switches. The transmitter includes only two pivoting members and requires only four adjustments for satisfactory operation. It is designed to operate on 6-volt direct current, obtainable from storage or dry batteries, but it can be adapted to alternating current by a change in coil resistance.

The salient parts of the instrument can be seen in the accompanying photograph. Basically the mechanism consists of a toothed wheel that engages a dog on a tangentially mounted arm and moves it horizontally toward the contactor. The dog is designed so that its leading edge has an angle of 45°, and its trailing edge an angle of 30°. The dog can be moved by the gear in one direction only, since the 45° angle will mesh with the gear teeth while the 30° side will ride over them. The contactor, a magnetic mercury switch, is one of the features of the instrument in that it provides a non-corroding contact and, being frictionless, introduces no drag in its operation. The contact is effected when a small, permanent horseshoe magnet mounted on the tangential arm approaches the mercury switch close enough to attract the enclosed armature, which in turn completes an electrical circuit. The 200-tooth gear is mounted on a shaft rotating in a double ball-bearing housed in the cast aluminum frame.

A pulley mounted on the opposite end of the shaft carries the cable, which is attached to a float resting on the surface of the water below. Rising water causes the pulley and gear to rotate counterclockwise, the diameter of the pulley establishing the depth interval of impulse transmission of the instrument. The instruments in use on the San Dimas Experimental Forest employ pulleys of two different sizes, having pitch circle lengths of 25 and 10 in., thus giving contact intervals of $^1/_8$ and $^1/_{20}$ in. of height, respectively.



THE SAN DIMAS WATER STAGE TRANSMITTER

Momentary closing of the electrical circuit activates the pen on the multi-pen recorder and also sends a surge of current through the electro-magnet of the transmitter. The function of this electro-magnet is to raise the magnet arm by attracting the soft-iron armature attached to it, thus lifting the dog above the gear rim and permitting the tension spring to return the magnet arm to its initial position. The pin moving in the slot below the electro-magnet limits the movement of the magnet arm. This retracting mechanism insures the transmission of only one impulse for each water-stage interval. This is considered an important advantage of the transmitter, since surges of water in the collector tanks may cause erroneous records if the contact for each water level, once made, is not broken promptly.

Under normal operating conditions the strip chart on a multi-pen recorder moves at the rate of 6 in. per hour. Individual contact marks on the chart cannot be distinguished if they occur more frequently than 10 per minute, thus establishing the highest rate of water flow measurable by single contacts. In order to measure greater flow rates and still maintain the sensitivity of the transmitter to low rates, a 10-counting switch is provided. Steel pins are set into the rim of the gear at 10-tooth intervals. The vertically pivoting arm at the right side of the instrument carries a tilting mercury switch. A cam under its upper end raises and lowers the arm as the 10-counter pins pass it. By adjusting its tilt, the mercury switch can be made to close the 10-counter-pen circuit just before the arm reaches its highest position and to open the circuit within two or three single counter contacts thereafter.

The single- and 10-counter circuits operate separate recorder pens. In this manner, if the single impulses occur so close together as to be indistinguishable, the rate for that period can be interpolated from the 10-counter record. A retractive mechanism is unnecessary in the 10-counter and has not been provided.

One pole of the magnetic mercury switch serves as a common return to the battery. The pen magnet of the recorder, and the retractive magnet of the transmitter, are connected in parallel on the other side of the battery. By this means a low-voltage current source may be used, but it is necessary to match closely the resistances of the magnet and recorder pen coils in order to insure the satisfactory operation of both.

The instrument described will transmit only rising stages, but if the float cable is run over the pulley in the opposite direction, falling stages can be transmitted. In order to make the device usable for stream-flow or well measurements, the authors have designed a model that will transmit both rising and falling stages. The gear in this model is twice as wide; and two opposed tangential contact arms, with their respective magnetic switches and retractive magnets, are mounted so that their contact-arm dogs rest in juxtaposition in the same gear-tooth interval. A rising stage will then move the wheel counterclockwise and produce impulses from one switch, and conversely a falling stage will produce impulses from the other.

Fifty water stage transmitters of the single-stage type have been providing satisfactory records of rain, runoff, and seepage on the San Dimas lysimeter installation for the last five years.

Complete working drawings for the construction of a water stage transmitter are available on request to the Director of the California Forest and Range Experiment Station, Berkeley, Calif.

Maximum Stress on Eccentrically Loaded Sections

By ROY W. PURCHASE, JUN. AM. SOC. C.E.
STRUCTURAL ENGINEER, PITTSBURGH, PA.

ON sections where no tension is permitted—such as foundations, piers, and chimneys—it is necessary to solve for the maximum bearing or compressive stress to ascertain whether it is within a certain predetermined allowable value. In the past, engineers have cautiously required that the resultant load be applied within the kern of the section, or nearly so. When the resultant load is applied within the kern, the flexure formula, $f = M/S$, may be employed because the entire section is subjected to stress.

When the material cannot be, or is not, permitted to sustain any tension stress and the resultant load is applied outside the kern, the flexure formula is no longer applicable, so the maximum stress must be determined by the equations of static equilibrium. Solution of these equations is a very complex and tedious process in many cases, especially in cases of eccentricity in two directions, and consequently has been avoided by keeping the resultant load within the kern, or very nearly so. This attitude has led many to infer erroneously that for stability it is necessary for the resultant load to be applied within the kern. The two together have often resulted in uneconomical designs or analyses, because designers have increased the size of the section in order to enlarge the kern when the allowable stress might not in many cases have been exceeded or the stability endangered if the resultant load were applied outside the kern.

By simplifying the solution for the maximum stress for some common sections by means of diagrams, the writer has attempted to effect economy in design and analysis and thereby remove the fear of having the resultant load fall outside the kern. These diagrams (Fig. 1) simplify the expression of the relation existing between the eccentricity and a coefficient when the resultant load is directed through the centroid of the stress diagram. From these diagrams the value of the coefficient, K, can readily be obtained after the pertinent ratios have been computed. Then the maximum stress can be quickly computed by substituting K in the very simple formula, $f = P/KA$. In this formula the resultant load, P, must be applied within the extreme boundaries of the area, A, in order to maintain stability; the coefficient, K, depends on the eccentricity of the resultant load and the shape of the section; and the maximum stress, f, occurs at the extreme fiber of the section which is nearest the point of application of the resultant load. Also the usual assumption is made that an unstressed plane section remains a plane when stressed.

This method is not limited by the conception of the kern, nor is it directly concerned with it. However, as indicated in the following outline, the general nature of the stress diagram can be determined from the zones of the K-diagram and the accompanying sketches of corresponding types (Fig. 2). A knowledge of the qualitative stress diagram is of no importance mathematically, but as an aid in understanding the situation in hand it may be of some value. The quantitative stress diagram could be obtained by means of other diagrams but its

properties, other than the maximum stress and general type, are not of sufficient importance to justify the labor involved. The notations used are as follows:

General:

P = resultant eccentric load
A = area of section
f = maximum compressive or bearing stress
K = coefficient obtained from K diagram
M = total moment due to eccentricity of direct load
S = section modulus
e_x = eccentricity of resultant load from Y axis
e_y = eccentricity of resultant load from X axis
e = radial eccentricity = $\sqrt{e_x^2 + e_y^2}$

For solid rectangular sections:

B = length of side parallel to X-axis
C = length of side parallel to Y-axis
A = area of section = BC

For solid circular sections:

D = diameter of section
R = radius of section
A = area of section = πR^2

For circular ring sections:

D = outside diameter of section
R = outside radius of section
r = inside radius of section
A = area of section = $\pi(R^2 - r^2)$

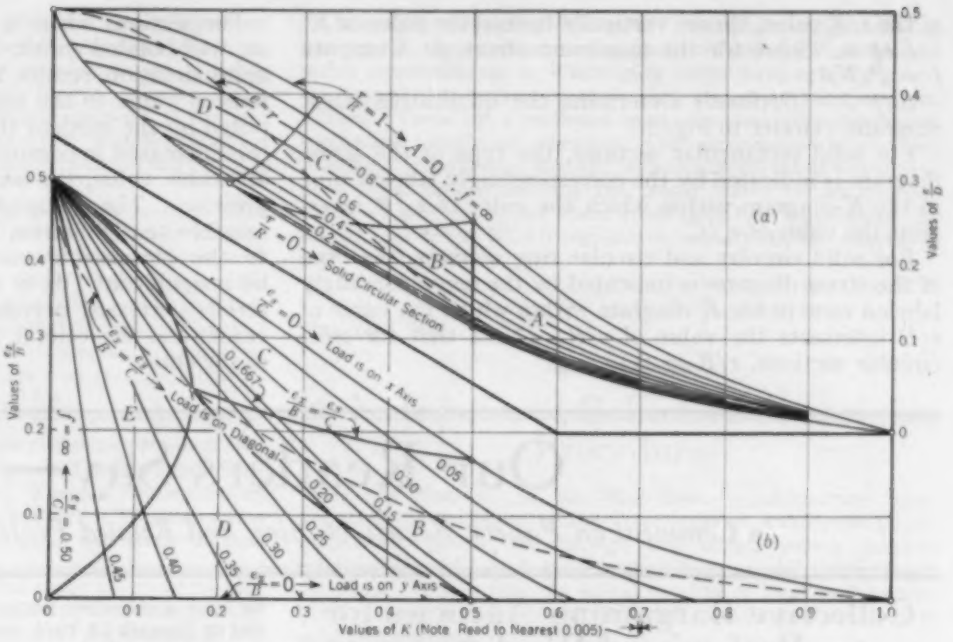


FIG. 1. VALUES OF COEFFICIENT K FOR ECCENTRICALLY LOADED SECTIONS
(*a*) For Ring and Circular Section, (*b*) for Rectangular Sections

The general solution for any problem of this type, using the subject method, is as follows:

Step 1. Find the resultant load, P, and its eccentricities, e_x, e_y, and/or e.

Step 2. Determine the area of the section.

Step 3. Compute the required factors and enter the K diagram to obtain the value of K. (Note that interpolation will probably be necessary but that the error will be less than 1%.)

For a more precise position of K (usually unwarranted) when P is applied within the kern, use:

For solid rectangular sections, $K = \dfrac{1}{1 + 6(e_x/B + e_y/C)}$

For solid circular sections, $K = \dfrac{1}{1 + 8e/D}$

For circular ring sections, $K = \dfrac{1}{1 + \dfrac{8e/D}{1 + (r/R)^2}}$

For octagonal sections, a reasonably approximate solution by this method can be obtained by assuming a circle of equivalent area, that is, one where $D = 1.027Q$, in which Q is the short diameter of the octagon.

For solid rectangular sections:

Compute the ratios, e_x/B and e_y/C.

Enter the K diagram for rectangular sections with the e_x/B value at the left horizontally to the curve of the e_y/C value, thence vertically to read the value of K.

For solid circular sections and circular ring sections:

Compute the radial eccentricity, $e = \sqrt{e_x^2 + e_y^2}$.

Compute the ratios; e/D and r/R. (Note that for solid circular sections, $r/R = 0$.)

Enter the K-diagram for ring and circular sections with the e/D value at the right horizontally to the curve

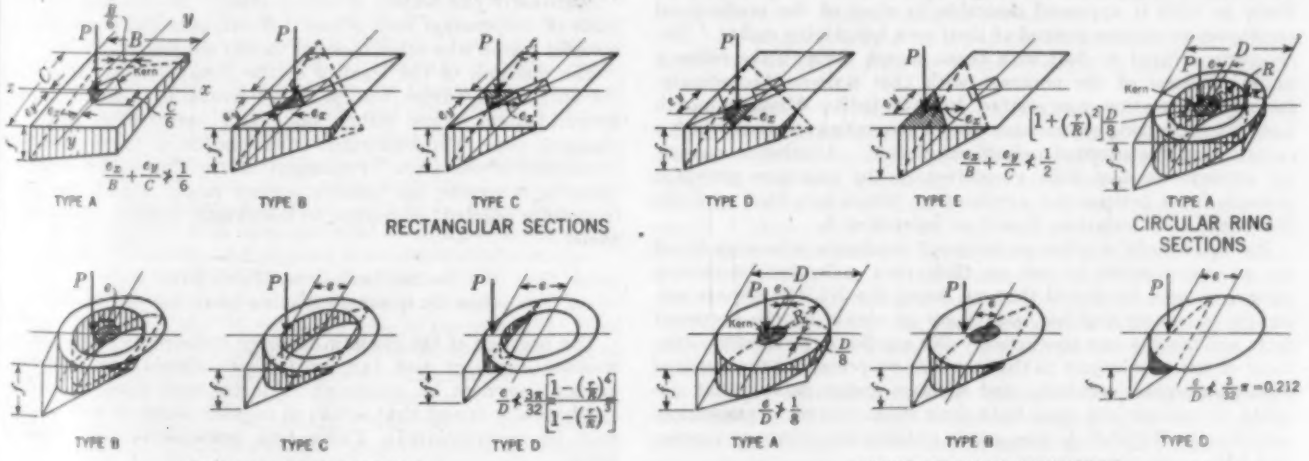


FIG. 2. TYPES OF STRESS DIAGRAMS

of the r/R value, thence vertically to read the value of K.

Step 4. Solve for the maximum stress, f. Compute $f = P/KA$.

Step 5. (*Optional*) Determine the qualitative stress diagram. (Refer to Fig. 2.)

For solid rectangular sections, the type of the stress diagram is indicated by the correspondingly labeled zone in the K-diagram within which the value of e_x/B intersects the value of e_y/C.

For solid circular and circular ring sections, the type of the stress diagram is indicated by the correspondingly labeled zone in the K-diagram within which the value of e/D intersects the value of r/R. (Note that for solid circular sections, $r/R = 0$.)

For sections where a limited tension is allowed, such as well-bonded brick or plain concrete, a practical approximation results by simply adding the allowable tension value to the maximum compressive stress computed by the method that has been described. Then, if this increased maximum compressive stress is within its allowable value, the section is not overstressed in compression. The assumption here is that, since the permissible tension stress is usually quite small compared to the permissible compressive stress, the error will be insignificant. It is also assumed that when the material is stressed beyond the allowable tension value, it cracks and thenceforth sustains zero stress for the extent of the crack.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Collective Bargaining Agencies for Professional Workers

TO THE EDITOR: From the interesting "pro" and "con" letters on collective bargaining that have appeared in CIVIL ENGINEERING, it would seem that the critics of A. M. Rawn and the Committee on Employment Conditions are Society members who have not had the experience of being represented willy-nilly by non-professional industrial unions. Until the end of February 1944, this was the situation at the Whiting Refinery of the Standard Oil Company (of Indiana). On February 29, however, the National Labor Relations Board gave official recognition to the Research and Engineering Professional Employees Association (R.E.P.E.A.), as the collective-bargaining agent for the professional engineering and research personnel at the refinery.

As far as we have been able to determine, this is the first officially recognized independent collective bargaining agency composed entirely of professional workers in the United States. Since at least fourteen of the Standard Oil Company employees are either present or former members of the Society and since the R.E.P.E.A. was organized for reasons practically identical with those cited by Mr. Rawn, it seems to me that other Society members ought to be informed of the organization of this association.

Prior to the recognition of the R.E.P.E.A., the bargaining agency for these professional employees was the local union of refinery workers, which was recognized by a contract with the company as the sole collective-bargaining agency for all employees (about 5,000) at the Whiting Refinery. This arrangement had been made in 1937 without obtaining the consent of the engineers and chemists, most of whom did not realize at the time what had occurred. Early in 1943 it appeared desirable to most of the professional employees to assume control of their own bargaining rights. The company refused to deal with them except through the refinery union, because of the contract with that union. Accordingly, formal organization was started June 5, 1943. About a month later the organizing committee called a general meeting, at which a constitution was adopted and officers elected. Another unsuccessful attempt to deal with executives of the company provided grounds for a petition for certification, which was filed with the National Labor Relations Board on September 3.

For the benefit of other professional employees who wish to set up an organization to act as their own collective bargaining agency, it may be stated that we found the NLRB officials uniformly courteous and fair, and eager to obtain all the pertinent facts and reach a just conclusion. We attribute the speedy settlement of our case largely to the fact that we presented the required data thoroughly, concisely, and without undue delay; that sincerity of purpose and good faith were evident in our organization; and that the R.E.P.E.A. was, and is, entirely free from any connection with management.

Readers of CIVIL ENGINEERING will be interested in the fact that the American Chemical Society has likewise recognized the need for such a collective bargaining agency for professional workers, and on January 15, 1944, published a pamphlet entitled "Collective Bargaining for Professional Employees"; also, that an organization known as the Association of Industrial Scientists has been formed at the Emeryville, Calif., laboratory of the Shell Development Company.

Society officers and the members of the Committee on Employment Conditions are to be commended for recognizing industrial conditions and accepting facts instead of burying their heads in the sands of tradition.

THEODORE F. DOLL, M. AM. SOC. C.E.
Member, Board of Directors, R.E.P.E.A.
Crete, Ill.

Collective Bargaining for Engineers

TO THE EDITOR: When the Board of Direction adopted the report of the Committee on Employment Conditions, a controversy was stimulated, which divides the membership and threatens the standing of the Society as a professional and scientific body. The issue is fundamental, involving the depths of conviction and arousing the emotions to the exclusion of calm opinion.

The action of the Board has been explained by reference to alleged authority and citation of previous publications supposed to prepare the way. These could not have indicated that so radical a measure was imminent. To propose such a momentous change without consulting the membership seems hardly the best method of establishing any policy—especially one so filled with controversial dynamite.

Apparently the Society is acting alone. No mention has been made of cooperation with others. If this plan has merit, there is no valid reason why other societies should not join us.

The question of the legality of the Board's action is not important; legal advice was probably available. However, good lawyers might argue either side. Our constitution might be changed, too. The important consideration is the wisdom and expediency of this plan. Proponents of the plan hold it necessary because, otherwise, an outside agency might absorb the "professionally minded" engineers, so laboriously defined. Some of us would

> ". . . rather bear those ills we have
> than fly to others that we know not of."

The prestige of the Society has been invoked as surety for immediate hearings and fair settlements should the bargaining agency's services be requested. At the same time it has been emphatically denied that action so unprofessional as a strike shall ever be contemplated. These two conceptions are somewhat naive.

The basic reason for collective bargaining, whether the laborers are professionally minded or simply acquisitive, is to threaten

with pressure of numbers. A threat of action, damaging to an employer's business, tempers his attitude. One who might entertain an affiliated union delegation or concede its demands through fear (knowing its strike threats meant business), would naturally be less amenable to the requests—adverse to his own interest—of a committee calling to have a nice sociable talk about employment conditions. For such mediations the Board's plan is fatally handicapped.

Force and coercion are the weapons in labor's arsenal. The strike is labor's means of compulsion. Without it, could millions have reached a dominant position? The advocates of this measure disclaim an intention to unionize the Society. They scorn the idea that parleys, to be successful, must be conducted by methods similar to those of unionized labor. How has labor won its battles? Through strikes, force, and violence! If this program is to prosper, labor's weapons may be needed. Reliance on prestige might be like fighting empty-handed with an armed foe.

A marked difference exists between our Society and an ordinary labor union. The Society has no disciplinary control over its members. One may resign with impunity, cease paying dues, and still hold a job. Not so in a union! There, a job depends on paying dues—often checked off by the employer. The consequent lack of solidarity in the Society organization will surely militate against it as a pressure group.

The writer believes that the Board has made a serious mistake in asking the Local Sections to adopt collective bargaining. Why not let those who feel the need establish a "Federation of Engineers" entirely separate from our Society, in which—just as it stands—some of us have felt pride for many years?

PIERCE FURBER, M. Am. Soc. C.E.

Wayne, Pa.

Shall the Engineering Professions Unionize?

TO THE EDITOR: I am torn with conflicting emotions by this grave and momentous question. I recently returned from Trinidad, where I witnessed the wholesale discharge of more than 250 engineers—in a sudden wave of stupid economy, after a wastage of 40 million dollars—at a time when they were needed to complete surveying, supervision, and so on. Orders from headquarters were to lay off everybody and, of course, the younger men were cut loose first. At that time I felt that those young engineers had no protection, no guarantee of some measure of security or permanence.

I also recall an incident related by a classmate who informed me that he worked for one of the largest steel mills in the country. Suddenly the entire engineering force were given four hours' notice of termination of their services. An entirely new group was hired the following week at 25% less salary.

Some form of protection is evidently necessary to prevent such exploitation of engineers and to assure them some degree of security. Is unionization the answer? I have fought against unions and for them the greater part of my life. Their need to counteract the exploitation of labor has been proved. The methods employed to obtain their objective is, however, completely incompatible with engineering ethics. I was once engaged as consulting engineer and technical adviser to an impartial chairman of one of the building industries, so am thoroughly conversant with the racketeering, double-crossing, and intimidating measures employed by union officials as well as by employers.

I am fully cognizant of the status of the engineer, especially the young engineer. He looks to us older engineers for leadership, guidance, and protection, and if we fail him he has no recourse other than affiliation with some powerful labor organization which will protect his interests and give him some measure of security.

Can the engineering profession afford to affiliate with labor organizations which employ unethical tactics to obtain their ends? The answer is definitely "No!" Then what is the solution? How will the engineer protect himself in the exercise of the principle of vertical unionism, which embraces complete industries?

The National Labor Relations Board exempts all doctors and lawyers from collective bargaining. Why were not qualified licensed engineers similarly exempt? Active lobbies in Washington, conducted by various bar associations and medical societies, saw to it that their professions were not lowered to a clerk's status. Where were our leaders in the engineering profession, when the NLRB regulations were promulgated? Our engineering leadership has proved supine, introversive, and ineffective. Vigorous and active representation in Washington might have resulted in exemption of the engineering profession, also, from collective bargaining. Certainly, a combined front consisting of qualified civil, mechanical, electrical, chemical, and aeronautical engineering societies represented by able and influential legal talent would have done much toward securing the proper status for all qualified engineers and exempting them from collective bargaining. An amendment to the NLRB regulations may still be the solution to this vexing problem.

PAUL BENTON, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.

Uncertainties of Collective Bargaining Procedure

TO THE EDITOR: In the May issue, supplementary interpretations of the report of the Committee on Employment Conditions are given. All through this supplementary material conditional words, such as "proposed," "suggest," "preferably," "proffered," imply that the actual wording of local by-laws and, in effect, even the amendment itself might be changed at will to fit local requirements.

These supplementary recommendations should greatly help the Local Sections and employee groups in perfecting their proper organization. The very form of the recommendations, which leaves openings for further modifications to suit local conditions, makes it more difficult now to offer any specific criticism. However, there are a few pertinent points on which the published recommendations could well be amplified. To some, for instance, it may seem imperative that uncertainties in procedure be formulated by the Committee on Employment Conditions rather than by Local Groups, who may have very diverse viewpoints and who may be too much influenced by strictly local experience with the result of non-uniformity of procedure.

The uncertainties in procedure may be listed as questions as follows:

1. (*a*) How can an applicant be judged eligible for membership, using only the "gages" given in the definition in Article II? (*b*) How many of these must be fulfilled?
2. Will the references requested (intended to verify the applicant's statements) be acceptable as evidence, and on what form of misstatement or other grounds can a legal rejection of the application be made? (It would seem desirable that a subcommittee on qualifications be recommended.)
3. If the applicant is rejected, how can he appeal without legal recourse?
4. (*a*) By what means can one or a group of accepted members be suspended or expelled? (*b*) How may they appeal?
5. In Article IV, paragraph 9, does the word "fixed," applying to dues in line 3, mean "adjusted"? (The actual procedure may be to "increase" dues, at least for a time.)
6. No mention is made of a possible coalition of Local Groups. Is this not expected, or is the Society's advisory position thought to be sufficient?
7. In Article VI Amendment, there appears to be no bar to an amendment by which the group may entirely dissolve its connection with the Society's sponsorship, and then reorganize as an independent group, providing that, after doing so, they do not immediately violate the four provisions of the recommended procedure. However, if they do, what happens next? Should it not be recommended that each Local Section of the Society may, when it so desires, withdraw its own sponsorship, and that it shall reserve the privilege of approving any proposed dissolution of the group from its relationship to the Local Section, before such action can take effect? (The legality of such a restriction may be questioned.)
8. If the employer does not desire to treat with individual employees, or Units, and insists on dealing with the main organization, to assure uniformity of action in similar disputes later, what should be the uniform procedure?

WALTER SAMANS, M. Am. Soc. C.E.

Philadelphia, Pa.

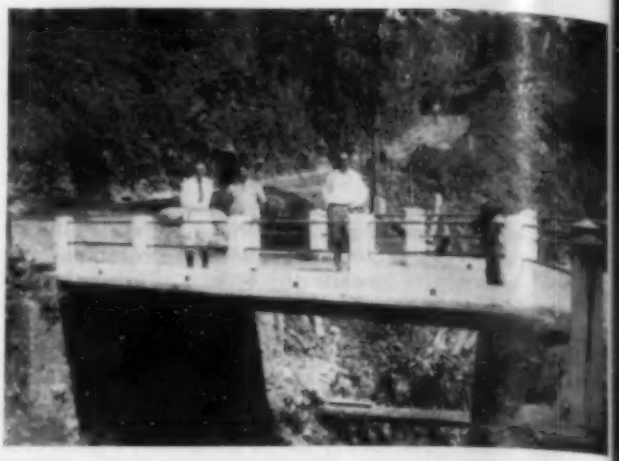
Comments on the Pan-American Highway

TO THE EDITOR: In the January issue E. W. James summarizes the history of the Pan-American Highway project and gives some details about its planning and construction. It is of interest to note that he has made the first reference, in any recent discussion of the subject, to the intercontinental railway project which antedated the highway scheme by many years. During the period when the Pan-American idea was first promulgated by Secretary of State James G. Blaine, there was appointed an Intercontinental Railway Commission composed of representatives of the United States and many of the Latin-American countries. Between 1892 and 1898 a survey and study were made, under the direction of this commission, by parties of military and civil engineers who worked in the field for several years.

VIEW OF THE INTER-AMERICAN HIGHWAY
In the High Country near Quetzatenango, Guatemala

Their report constitutes the first and most comprehensive study of the terrain along the route of the Inter-American Highway. Had such a railway been built as an extension of the Mexican system, it would doubtless have been of much military service in our defense project during the past two years. The Inter-American Highway was a peacetime project designed to promote communication between the various countries and tourist travel from the United States. It passed through, or near, the capital of each of the five countries and followed routes most convenient for interior communication. All of these factors tended to make the road longer and the grades steeper than would have been the case had it followed a course more suitable for heavy commercial or military traffic from Mexico to Panama.

With the outbreak of war, the desirability of a land transportation route through Central America was apparent, but evidently the opening of a highway was undertaken by the War Department without a preliminary study of conditions or an estimate of the minimum time necessary to complete it. As an alternative supply line to the Canal Zone, it was impossible to put the route into operation during the period when it might have been needed. The fact that construction supplies were transported by ship to various points on the Pacific coast in 1942 and 1943 shows that such transport of military supplies to the Canal Zone was feasible. From the viewpoint of national defense, however, it would appear that the money and energy that have been put into this road under Army supervision have been largely wasted.



DEPARTMENTAL HIGHWAY AS MODERNIZED BY LOCAL ENGINEERS
Sharp Turns Are Usual on Such Highways

Because of the high elevation and the steep grades and curvature on the existing road through the highlands of western Guatemala, which has been usable for automobiles throughout most of its length for the past ten years, the new construction followed the general line of the old intercontinental survey near the coast. But in Costa Rica the line rises to elevations even higher than those in Guatemala and traverses previously unexplored territory.

Assuming that a military highway from Mexico to Panama was of prime importance, the coastal route should have been followed along the location made between 1892 and 1897 by the Intercontinental Railway Commission. When completed, the high-level route through Costa Rica will doubtless be picturesque for tourists but of little value for long-distance convoy transportation.

Nevertheless, it is probable that the construction now abandoned will be of future value even though it may not accomplish all the results predicted in our enthusiastic propaganda. A single tourist road through Central America can hardly have a marked economic effect on the immediate future development of countries that have been able to take care of themselves for a long time, nor will it necessarily make them more friendly to each other or to us. International friendship cannot be purchased by large subsidies, nor is it necessarily promoted by tourists, as a memory of the good touring roads of Europe may remind us.

HENRY WELLES DURHAM, M. Am. Soc. C.E.
New York, N.Y.

A Plea for Enlightened Engineering Criticism

TO THE EDITOR: We doubt if many engineers have examined or even heard of the *Dictionary of Occupational Titles* which is the official reference book of the U.S. Department of Labor and other government agencies in matters pertaining to job and occupational classifications. This dictionary was prepared under the direction of the Department of Labor in cooperation with the Social Science Research Council and the National Research Council. It is used extensively by the U.S. Employment Service in classifying applicants referred through their offices.

The engineers who furnished information to be used in the publication must have considered the request as just another government questionnaire. Unfortunately for the uninitiated, "Architectural Engineer, Chief (professional and kindred)" and "Engineer, Chief (radio broadcast)" are the only chief engineers listed in the book. There is nothing to indicate that any of the other branches of engineering have chief engineers.

There is an impressive list of engineering title definitions including such titles as "Rock-Tram Engineer, Combustion Engineer, Studio Engineer, Gas-Distribution Engineer, Insurance Engineer, Line-Construction Engineer, Mixer Engineer, etc." And there is the general definition of draftsman:

"*Draftsman* (professional and kindred). Prepares clear, complete and accurate working plans and detail drawings, from rough or detailed sketches or notes, for engineering or manufacturing purposes, according to the specified dimensions; makes final sketch of proposed drawing, checking dimensions of parts, materials to be used, the relation of one part to another, and the relation of the various parts to the whole structure; makes any adjustment or changes necessary or desired; inks in all lines and letters on pencil drawings; exercises manual skill in the manipulation of triangle, T-square, and other drafting tools; lays tissue on drawing and traces drawing in ink on tissue paper; makes charts for presentation of statistical data; makes finished designs from sketches; utilizes knowledge of various machines, engineering practices, mathematics, building materials, and other physical sciences to

complete the drawings. Classifications are made according to type of drafting such as Draftsmen, Architectural; Draftsman, Electrical, etc."

If this describes a draftsman, what does a designer or engineer do? No wonder the NLRB and other agencies classifying engineers sub-professionals have given decisions as they have.

With the spread of collective bargaining and the necessity for a clear understanding of the functions and responsibilities of the various grades in the engineering profession, it is most essential that all branches of engineering get together and prepare adequate definitions for use in this book, which is even now used as a legal reference. The preface to the first edition states: "It was thought wise to present an edition..., relying on suggestions and criticisms of users to furnish appropriate guidance for a subsequent edition."

Please let's make those criticisms and give some constructive guidance that will make sense of the definitions of engineers.

D. V. PURINGTON, Assoc. M. Am. Soc. C.E.
Resident Engineer, Texas Highway Department
Fort Stockton, Tex.

Defining the "Professional Engineer"

DEAR SIR: In view of recent discussion of definitions of "professional engineer," I believe that many readers will be interested in the "ten criteria or earmarks of a genuine profession," advanced by Dr. Byrne J. Horton, of St. John's University, and published in the February 1944 issue of *The Scientific Monthly*.

Dr. Horton is stated to have arrived at these criteria by contemplation of the professions of law, medicine, theology, and advanced teaching. He does not even mention engineering, but his criteria seem to fit engineering better than any of the professions named, except medicine.

The "musts" set forth by Dr. Horton are epitomized as follows:

1. Satisfy an indispensable social need and be based upon well-established and socially accepted scientific principles.
2. Demand an adequate preprofessional and cultural training.
3. Demand the possession of a body of specialized and systematic knowledge.
4. Give evidence of needed skills which the public does not possess—skills which are partly native and partly acquired.
5. Have developed a scientific technique which is the result of tested experience.
6. Require the exercise of discretion and judgment as to the time and manner of the performance of duty.
7. Be a type of beneficial work, the result of which is not subject to standardization in terms of unit performance or time element.
8. Have a group consciousness designed to extend scientific knowledge in technical language.
9. Have sufficient self-impelling power to retain its members throughout life—not be used as a mere stepping-stone to other occupations.
10. Recognize its obligations to society by insisting that its members live up to an established and accepted code of ethics.

C. K. HARVEY, M. Am. Soc. C.E.
Pittsburgh, Pa.

Use Made of Geodetic Surveys in Los Angeles Engineer District

DEAR SIR: In connection with the article by Alfred Jones on "Geodetic Control Surveys Around Los Angeles," in the May issue, it may be of interest to discuss the practical use made by the Los Angeles Engineer District of geodetically controlled surveys. Prior to the war, the District was engaged in a comprehensive flood-control and harbor-improvement program. This work called for considerable survey work which, as far as practicable, was tied to the existing triangulation nets. All topographic surveys performed either by planetable or aerial photography, in conjunction with the use of stereoscopic plotting devices, also are controlled by tying pertinent survey points to the established horizontal control either by triangulation or traverses.

Cadastral surveys, irrespective of the area involved, are tied to the triangulation net at least in one place, and in the case of large tracts are tied twice. It should be mentioned that considerable cadastral survey work has been performed in areas throughout the Los Angeles Engineer District, where no control except geodetic exists. This is especially true in the large ranchos where the basis of title dates back to the original Spanish grants. The islands off the southern California coast are also in this category. The basis for the rectangular coordinate system used is predicated on the zone system established by the U.S. Coast and Geodetic Survey for the locality in which the work is performed.

Other types of work which our office has been called upon to perform are the determination of runway directions on airfields, and in some instances the computation of distances and true azimuths between fields. Both are accomplished by the use of geodesy. The geodetic position of the intersection of the principal runways is determined by triangulation breakdown from the most suitable net stations. Azimuth of runways is determined by measuring the angle at this intersection between one of the net triangulation stations and the runway center lines. Distances and azimuths between airfields are determined by the computation of geodetic inverses. The basic data needed for the establishment and calibration of compass swinging bases at various airfields is determined much in the same manner as directions of runways.

The directional calibration of certain types of radio receiving sets is materially facilitated by the use of triangulation stations. This is accomplished by originating the signals from the station itself or by occupying the stations and cutting in a plane simultaneously from two or more triangulation stations as a signal is broadcast from the plane. It has been particularly advantageous to this office that triangulation stations are numerous along the coast line in the vicinity of these receivers. Many of the stations used in this type of work were set by the Los Angeles County Engineer.

One of the functions of our office has been supplying basic horizontal and vertical control to various military commands throughout the Los Angeles Engineer District. It was possible to discharge this function with a minimum of delay, as the descriptions and geodetic positions of all the control filed in this office are contained on reproducible forms.

A high percentage of all the work performed in the Los Angeles Engineer District has been in Los Angeles County, which is well controlled by geodetic surveys performed by the U.S. Coast and Geodetic Survey, the City of Los Angeles, and County of Los Angeles. All these institutions have furnished their data, which has enabled this office to carry out the work outlined much faster and with less expense than would otherwise have been possible.

DONALD L. WILLIAMS
Engineer, Surveying and Drafting Department, U.S. Engineer Department
Los Angeles, Calif.

Uncertainties of Planning for "The Future"

DEAR SIR: In the April issue Mr. Archibald said he would be interested in other viewpoints on the subject of building with a view to meeting conditions for a long time in the future. The following illustrations bear on the subject.

When the Mexican National Railroad from Mexico City to the Rio Grande River was changed from narrow-gage to standard years ago, the management decided to build all bridges for a double track, as double-tracking would be the next step. Before the railroad was double-tracked, however, the weight of the rolling stock had increased so much that the bridges would no longer suffice.

A few years ago a brilliant English woman was in this country studying housing. I said that I supposed the many frame houses of poor construction in Savannah rather horrified her. She replied that on the contrary they delighted her. The curse, she said, of English houses was that they were so well built that it was expensive to tear them down and people clung to them rather than build new ones. She said that old stone houses with earth floors and no windows (dating back to the days when windows were taxed) were still used to the detriment of the health and comfort of the occupants. It was difficult to get such houses torn down, while here we were practically forced to build new ones because the old ones had become untenable. She ascribed our many advances in plumbing and convenient household arrangements largely to the fact that we

were always building new houses in large numbers, and when they were built they were naturally made up-to-date. Thus our buildings were more sanitary and comfortable than if they had been built for permanence. She added that if she could do it she would pass a law requiring that all private houses in England over a given age (historical monuments of course excepted) be torn down, claiming that it would improve the health of the English nation.

A certain pertinent remark comes to mind. About 30 years ago the U.S. Geological Survey announced that if we continued to use our coal at the increasing rate which then obtained we should have none left in this country in 3,000 years, or some such period. We were then at the height of the conservation fever. I read the article to a brilliant young engineer who remarked, "Neither Abraham, nor Isaac, nor Jacob—nor any of those old boys—bothered about me—why should I try to regulate people who will be here thousands of years after my time?" The same idea holds good for periods shorter than 3,000 years.

These cases illustrate the difficulty and absurdity of forecasting developments too far in advance, and the harm in building too well. There is another reason. If we could build all our structures to last, say 100 years, we should find at the end of that period that we would have lost much of our ability to build. Nations, like individuals, need the incentive of being forced to constant effort.

We should be reasonable in our provisions for the future. The 20-year provision for highway structures quoted by Mr. Archibald seems to me more sensible than the 70-year provision.

F. W. ALTSTAETTER, M. Am. Soc. C.E.

Savannah, Ga.

Forum on Professional Relations

CONDUCTED COLUMN OF HYPOTHETICAL QUESTIONS WITH ANSWERS BY DR. MEAD

In the current issue Dr. Mead gives his answer to Question No. 21, which was announced in the April issue of "Civil Engineering." The question states: "An engineer is making plans and specifications for a sewer system. Is it ethical for him to be financially interested in a concern manufacturing an article that may be used under the specifications, such as sewer pipe?"

Sixty years of somewhat active practice in the engineering field have convinced the writer that all engineers are more or less human. Since we are thus subject to the frailties of humanity, the writer believes that it is important for the man who desires to render the best service to his clients to take this fact into account and to see that he does not acquire habits or put himself into unnecessary positions or relations that will influence his judgment in unfortunate ways. Among the frailties of humanity is bias, of which personal interest is probably the largest factor.

The writer once had a friend who was a good engineer and who, for some years, was the superintendent of a rather large waterworks system. During this friend's administration there was a demand for a new, larger, and more satisfactory water supply. Conditions in the neighborhood of the municipality in question indicated the possibility of a very satisfactory supply of underground water. The superintendent and engineer designed a large well for this location which was somewhat unique and had many good points—in fact, the novelty and intrinsic value of the design were such that the man finally had the design patented. Later, after the city purchased the works, this man entered the field of consulting engineering making a specialty of public water supplies, in which he was, in fact, really a specialist.

As the writer was in somewhat close touch with this man, he knew about some of the work he was called upon to do, and to his great surprise found the patented well system used in places to which, in his judgment, it was not adapted. In one municipality, a well of this design was completed under pneumatic pressure and, on account of the peculiar soil conditions, was immediately filled, as soon as the air pressure was removed, with fine material, sand, mud, and so on. The well was a total failure, and the engineer lost his position on that account. Later, the writer was called in to advise on the water supply. Although his relationship with his friend had ceased a year or more before he was called to look into this matter, he advised the city that he felt it was only justice to the previous engineer to consult with him and to try and gain as much information as possible about the failure that had resulted from the previous design. The writer made a special trip to the office of his friend, told him the circumstances, and tried to discuss the matter with him in a friendly spirit. He found, to his surprise, that his friend still was convinced that his patent well should have been a success and that they should try essentially the same design again.

The writer believes that he personally would have realized in the first instance that the well could not possibly (without a miracle) have been successful under the prevailing conditions. He could not see that any such design should ever have been attempted. There were other methods and other sources of supply that undoubtedly were quite superior in every way to the one that had been attempted, and he was obliged to tell his friend plainly the way he saw the matter and to say that, under the existing conditions, he could not attempt to use his friend's very excellent design. As a matter of fact, the writer developed artesian wells which were available, and while this work was done many years ago, the artesian wells apparently have been supplying the city with an entirely satisfactory supply and, the writer believes, with much more economy than his friend's design even had it been a success. Obviously the engineer in question never consciously realized that his financial interest was influencing his judgment.

This experience has been described in some detail for the reason that it was exceedingly striking and fairly represents many other observations of the writer that might be greatly extended. The conclusion which the writer wishes to draw from this and his other experiences is that when a man has a special interest in a design, and especially when he has any financial interests involved, he becomes unconsciously prejudiced and his judgment is very greatly weakened. No engineer should ever have a financial interest in the use of machinery, materials, patents, and so on, in the work that he is doing for his clients. Any such interest is bound to exert a prejudice that the individual himself is seldom, if ever, able to resist. The writer has felt so sure of this conclusion that he has always applied it to himself and his associates. In one case an associate of the writer held a valuable patent on a certain feature of a structure that he and his associates were occasionally called upon to design and construct. For this reason the writer always insisted that, in the contract for services drawn for his client, this patent should be mentioned and the statement made that if it seemed desirable to the engineers that it be used in the structure, it would be furnished without any additional compensation. This action, he believes, largely relieved his associate and himself from bias. While quite largely used by other engineers, the patent was very seldom found essential to the particular designs on which the writer was personally engaged, although it was sometimes used for his clients entirely without compensation therefor.

The writer has discussed this matter with some of his old engineering friends, with the result that one or more of them sold their patents in order to avoid the suspicion of influence. The writer appreciates the fact that bias is natural under such conditions, and suspects that he might even be influenced by similar conditions.

All of us can see the faults of others, but unless we are very conscientious in considering and attempting to eliminate our own special faults, it is seldom that we can see them in ourselves.

Thus the writer, in answer to Question No. 21, would conclude that it is unethical for any engineer to be financially interested in any way with supplies, machinery, patents, equipment, and so on, used in the work that he is designing or executing for his clients.

DANIEL W. MEAD, Past-President and Hon. M. Am. Soc. C.E.

Madison, Wis.

Replies for the following question may be received until July 5, with answers in the August issue.

QUESTION NO. 23: *A young engineer, A, is employed by a certain firm and is—by verbal agreement—to remain with the company for two years. At the end of the first year, he is approached by another firm which desires to employ him. "A" does not mention his agreement with the first firm but suggests a salary which he considers so exorbitant that it would not be considered. The new firm, however, is satisfied with the salary mentioned and agrees to it if the young engineer will immediately undertake the work. What should the young engineer do?*

SOCIETY AFFAIRS

Official and Semi-Official

Planning for the Cleveland Convention

THE TIME is Wednesday to Friday, July 19–21. The place is the Hotel Cleveland adjacent to the Cleveland Union Terminal. The occasion is the 1944 Annual Summer Convention of the Society.

Actually, the preliminaries start on Sunday, July 16. At that time committees of the Board, including the Executive Committee, will sit down to thrash out various Society problems. Monday and Tuesday are reserved for the regular meetings of the Board, with either two or three sessions each day. Running concurrently on Tuesday will be an all-day Local Section Conference. This will bring together representatives from Society groups in the general zone contiguous to Cleveland, comprehending the twenty-five Local Sections east and north of the Indiana–West Virginia–Virginia areas. This conference is regularly one of the fruitful gatherings at Society meetings. It presents an opportunity for Society officers to share their problems with the local officers—and perhaps even more important, it furnishes a forum where important ideas of Local Section administration can be argued pro and con to the advantage of all the delegates.

Then on Wednesday morning, the nineteenth, the Convention will officially start. After registration and the courtesies of formal greetings, the meeting will be privileged to listen to the President's Annual Address. This is the one obligatory feature of the Convention—the remainder is subject only to the best judgment of those in charge.

For example, the Wednesday afternoon program is especially timely. The entire session is to be devoted to the question of postwar construction, under the sponsorship of the Society's Committee on Postwar Construction. A variety of interesting papers and discussions is in prospect.

That evening, another fixture of Society Conventions is promised—the dinner dance. It will be held right in the hotel. Reflecting the tempo and restrictions of wartime, the dress will be informal—a provision that appeals especially to the men.

Without attempting to go into detail as to the technical program that follows, it may be said that sessions are to be held morning and afternoon on both Thursday and Friday, for which various Technical Divisions are planning attractive programs. In all, twelve sessions are in prospect. The Sanitary Engineering and the Surveying and Mapping Divisions promise two sessions, morning and afternoon on Thursday, to be supplemented by one session of the Soil Mechanics and Foundations Division, and one of the Structural Division, Thursday afternoon. Six Divisions are planning sessions for Friday, including the City Planning, Waterways, and Construction groups in the morning, and the Engineering Economics, Highway, and Hydraulics Divisions in the afternoon.

As an interlude in this extensive technical program, an entertainment and social evening is being arranged for Thursday, also in the headquarters hotel. Both the Wednesday and Thursday evening programs will include the ladies. In addition there will be a full schedule of special entertainment for them. Some sightseeing may be feasible but it seems that technical inspection trips are out of the question, as may be readily understood.

All plans, both for technical and social occasions, have been concentrated as regards location, and will be held at the Hotel Cleveland. This

LORAIN AVENUE BRIDGE OVER ROCKY RIVER, AN EXAMPLE OF CLEVELAND'S FINE ENGINEERING ACCOMPLISHMENTS

UNLOADING AN ORE BOAT—CLEVELAND RECEIVES AND PROCESSES VAST QUANTITIES OF MINERAL PRODUCTS

will make for convenience, particularly because of the central location, and the ease of access to out-of-town guests. The committee emphasizes that those planning to attend should make reservations in advance. Experience in the past, particularly of those who have been disappointed in securing accommodations, emphasizes this need. In writing the hotel, it should be mentioned that the rooms are for persons who will attend the Society's Convention. Otherwise, the hotel may not honor the request by releasing rooms it is reserving for this special purpose.

The July CIVIL ENGINEERING will carry the official program of the meeting, giving all details. It is believed that this fuller notice will convince all members that there is an attractive meeting in store for them in Cleveland next month—a treat for the mind as well as for the spirit. This preliminary notice is mainly for the purpose of stimulating advance plans for attendance at the Cleveland Convention.

Meeting of Board of Direction—Secretary's Abstract, April 24 and 25

THE BOARD OF DIRECTION held its spring meeting at the Coronado Hotel, St. Louis, Mo., on April 24–25, 1944, at the time of the St. Louis Local Section's spring meeting. Present were President Malcolm Pirnie as chairman, and George T. Seabury, Secretary; also the following members: Past-Presidents Black and Whitman; Vice-Presidents Agg, R. E. Dougherty, Hastings, and Thomas; and Directors Bakenhus, Boughton, Breed, Burpee, Dickinson, N. W. Dougherty, Edwards, Gamble, Goodrich, Hathaway, Hollister, Lilly, Rawn, Scobey, Tolles, and Wilson.

Minutes Approved

With slight correction, minutes of the Board meetings held on January 17–18, and January 29, 1944, were approved as written. Similarly, minutes of the Executive Committee meeting of March 29 were approved as written and the actions therein noted were made the actions of the Board.

Dues for Service Men

It was voted to continue the practice of remitting 1944 dues of service men having base pay of $2,400 or less, upon individual request. The dues of 471 such members were remitted.

Economic Status of the Engineer—Joint Study

The Board approved of joining with the American Society of Mechanical Engineers and the American Institute of Electrical Engineers in a joint study to be made by the National Industrial Conference Board on "The Economic Status of the Engineer." Necessary provision for financing this study was also made.

Society Report on Depreciation

A voluminous report on Depreciation has been made by a committee of the National Association of Railroad and Utilities Commissioners. Its importance impelled the President to appoint a special committee, headed by Past-President and Honorary Member Henry E. Riggs, to study it. Progress report by this special committee has been made available to the Board members and discussion developed that it was deemed important to press the matter of publicizing the views expressed as in contrast to the N.A.R.U.C. findings. The Society committee's Progress Report was therefore accepted to be used (1) in an effort to secure suitable revisions of the original N.A.R.U.C. report; and (2) by publication in one of the Society journals for the information and comment of members. (See page 269 of this issue and the forthcoming June issue of PROCEEDINGS.)

To Accommodate 1945 Annual Meeting

Because of difficulties experienced in the past in satisfactorily handling all the technical sessions of the Society's Annual Meeting in the Headquarters building, it was determined that the sessions for January 17–19, 1945, would be held at the Hotel Commodore in New York City. As always, meetings of the Society's Board of Direction will be held in the Headquarters Board Room.

By-Laws Amended: Committee on Private Engineering Practice Substituted for Committee on Fees

Final action was taken on a proposed amendment to the By-Laws, Article IV. Committees, Section 11, Paragraph 3, whereby the previous "Committee on Fees" was superseded by a "Committee on Private Engineering Practice," with a restatement of the duties of the committee, as noted in more detail in a separate item on another page.

Postwar Construction

The Board listened to a report from G. Donald Kennedy, Chairman of the Society's Committee on Postwar Construction, and to Vincent B. Smith, executive director of the Committee's Research and Development Division. The constitution and purpose of this research work was explained (see May issue, pp. 217–218) and requested appropriation of funds was approved.

Reappointment—Secretary and Treasurer

Taking action as required by the Constitution, the offices of Secretary and Treasurer of the Society were filled. The incumbents, Messrs. George T. Seabury, Secretary, and Charles E. Trout, Treasurer, were reappointed.

Long Services of Walter Jensen

Recognizing twenty-five continuous years of service of Walter Jensen, in charge of the bookkeeping and accounting offices of the Society, the Board voted two months' leave of absence with pay.

Developments Re Employment Conditions

The Board devoted much time to several phases relating to its previous recommendation to the Local Sections that they make provision in their Constitutions for the establishment of local Committees on Employment Conditions, prepared to assist in instances of collective bargaining by professional engineering employees. A report by Howard F. Peckworth, Assistant to the Secretary, related experiences which had been observed recently, including the progress of the case that the Executive Committee has considered important as undertaken by the Tennessee Association of Professional Engineering Employees.

Communications to the Board made recommendations of various character, as to alternative procedures, more extensive publicity and greater opportunity for the publication of adverse comments. These all received considerate attention, some being referred to the Society's Committee on Employment Conditions for report as to their practicability.

The Board was in receipt also of counterparts of a petition, signed by 293 members (later a total of 483 were received), asking for a referendum of the question to the entire Corporate Membership; these also received considerate attention. The Board was aware also that 25 Local Sections had amended their Constitutions, 2,435 having voted in favor and 365 having voted in disfavor. The action of the Board was to adhere to its previous attitude.

Glossary on Water Control Engineering Terms

In connection with the report of the Committee on Publications, the Board accepted its recommendation that the Society cooperate in a joint endeavor to compile a comprehensive glossary on Water Control Engineering Terms; and to contribute its appropriate share to the preliminary expenses.

Canons of Ethics

The Committee on Professional Conduct reconsidered and reported its general attitude towards the proposed Canons of Ethics, suggested by the Engineers Council for Professional Development, and indicated its purpose to attempt to compile a revised Code of Practice applicable to civil engineering practice. The Board approved.

Inactive Student Chapters

Several of the Society's Student Chapters were reported to have become inactive owing to war conditions. On recommendation of the Committee on Student Chapters, the Board voted to continue the same privileges of Society affiliation as heretofore.

Postwar Education

The Committee on Engineering Education reported a series of studies, in progress and proposed, having to do with student bodies, curricula, teaching personnel, budgets, and similar matters. After extended discussion of possible emergencies in education following the war, the report was accepted.

Registration

The report of the Committee on Registration of Engineers centered around the topic of the "Engineer-in-Training." The Board voted to urge on the various State Boards of Engineering Examiners that they proceed as rapidly as possible to secure amendment of their laws, or to the development of rules, whereby this new classification may become generally available in the near future.

Regular Amendments to Local Section By-Laws

Independent of the consideration of collective bargaining, certain Sections were reported to desire to amend their by-laws. Approval was given in the case of the Kansas City and Utah Sections, the latter now to be known as the "Intermountain Section."

Congressional Control of Salaried Positions

Report was received from E. Lawrence Chandler, the Society's representative in Washington, covering various matters. Specific action was taken with regard to a pending law which would require the consent of the Senate to appointment to federal positions paying $4,500 per annum or more. Wording of the Board's resolution, in opposition to this bill, is given elsewhere in a separate item.

Further Committee Reports

A number of other committees reported progress on activities in connection with their special assignments.

Other Matters

Elections to membership, appointments of Society representatives, and numerous other matters were considered, with appropriate action in each instance.

Thanks to St. Louis Section

An appreciative vote of thanks was tendered to the St. Louis Section for its hospitality, likewise to the Circle Club of St. Louis, and to Mr. and Mrs. W. W. Horner for the entertainment provided by them.

Adjournment

The Board adjourned to meet in Cleveland, Ohio, Monday, July 17, 1944.

St. Louis Spring Meeting

IT SHOULD be understood that the St. Louis Spring Meeting, during the week of April 24, was not a function of the whole Society. Rather, it was an amplified Section meeting which certain Society officers and others were able to attend. It was held in conjunction with the regular Spring Meeting of the Board of Direction, and included also the Local Sections Conference described elsewhere in these pages.

Since the Board and Section meetings were coordinated, it is convenient to consider them together. For the record, it should be stated that the Board committees met on Sunday, April 23, and the Board itself both morning and afternoon on Monday and Tuesday, April 24 and 25. These meetings, as well as those sponsored by the St. Louis Section on the following days, were well attended, and the emphasis was on constructive features of Society activities and the profession as a whole.

Although not on the schedule, the Midwest weather was very much a part of the proceedings. As the meeting was about to start, a heavy rainfall amounting to seven inches or more throughout the Missouri and upper Mississippi valleys gave an emphatic demonstration of what the forces of nature are able to do. All early arrivals, particularly those from Kansas City, were seriously handicapped by the floods. Delays ranging from a few hours to the major part of a day were the rule. The flood, as it passed St. Louis, was of interest especially to out-of-town visitors. Otherwise, the weather from Sunday on was quite seasonable, with only minor rainfall.

BOARD ROYALLY ENTERTAINED

A summary of the Board's activities will be found on another page. Two entertainment features during its meetings are of note. On Monday noon, in the headquarters hotel, a luncheon was given to the Board and members of the staff by the Circle Club of St. Louis. This organization, almost forty years old, was originally composed of consulting engineers but now includes other engineers by invitation. The origin of the name is somewhat in doubt but according to F. W. Green, M. Am. Soc. C.E., who presided, meetings of the club have always involved a square meal, not forgetting a generous piece of pie. Now, inasmuch as the size of the pie depends upon the area of a circle, which in turn is a function of "π," the Club was indissolubly connected with the circle. In keeping with this definition, the lunch was amply square, and the pie both circular and large. Socially the occasion was casual, the only formality being a brief response by President Pirnie.

Another event of most pleasing character, which served to break the routine of the Board sessions, occurred that evening. This was a reception and buffet supper for the Board and the Local Committee, together with their wives, at the home of Mr. and Mrs. W. W. Horner in suburban Clayton. Automobile transportation was provided by local members, permitting views of Forest Park, Washington University, and the fine expressway through the park en route. Following a fine buffet supper, general sociability was the rule. Enthusiastic group singing was also enjoyed. Some sixty or more people were present on this delightful occasion.

LOCAL EMPHASIS AT WEDNESDAY MEETINGS

Engineers to the number of almost 200 gathered for the technical meetings on Wednesday, under the auspices of the St. Louis Section. As president of the Section, R. W. Hodson opened the morning meeting. Response was made by W. W. Horner on behalf of the local group. An interesting paper was then presented by George C. Smith, president of the Chamber of Commerce, on "The Needs, Physical and Economic, of the City of St. Louis in the Postwar Era." The activities and planning of engineers was given full credit by Mr. Smith in his summary.

In the afternoon the session was under the guidance of H. E. Frech, vice-president of the Section. The first topic was "Fundamentals of Flood Control," presented by Col. Malcolm Elliott, with enlightening discussions by Col. L. B. Feagin and Albion Davis. In connection with his talk, Colonel Elliott showed a most interesting colored movie, depicting flood conditions in the St. Louis area in 1943, together with the various engineering and related activities carried out so successfully.

GROUP ON THE STEPS OF THE CORONADO HOTEL AT THE ST. LOUIS SPRING MEETING IN APRIL

The next topic on the afternoon program was "Flood Control Plans for the Missouri River," which was presented by Brig. Gen. Roscoe C. Crawford, with discussion by Lt. Col. Delbert B. Freeman. The final special topic was "Flood Abatement by Headwater Measures," forcefully presented by Howard L. Cook of the U.S. Department of Agriculture, with discussion by W. W. Horner. In addition, there were numerous comments and questions from the floor, all adding up to an interesting overall presentation on the subject of floods, which kept the large audience interested until late in the afternoon.

Two social events were also scheduled for Wednesday. Like the technical sessions, these were held at the Coronado Hotel. Following a special luncheon, President Pirnie made an interesting address on "The Engineer in Postwar Society." This arrangement and program encouraged those who attended the morning session to remain for that in the afternoon, resulting in a larger attendance.

Most popular of the social events during the meeting was the dinner and dance Wednesday evening, preceded by a social hour during which local members could get acquainted with out-of-town guests and vice versa. Immediately following the dinner came the main feature of entertainment, a talk by Prof. Gus W. Dyer of Vanderbilt University. His witty address was entitled "Free Enterprise Planning vs. Governmental Socialistic Planning." Vigorously he defended the thesis that free enterprise is superior to governmental administration of business. His address was widely applauded. An interesting demonstration of sleight of hand followed, after which general dancing was enjoyed.

Postwar Road Problems Studied

A smaller but attentive audience was on hand Thursday morning for a technical session revolving around highways and postwar activities. The presiding officer was Robert B. Brooks, vice-president of the Section. A prepared paper on "Inter-Regional and Postwar Highways" started this program. In it Carl W. Brown, chief engineer of the Missouri State Highway Department, and president of the American Road Builders Association, analyzed the government plan for the postwar period. He was followed by Samuel C. Hadden, chairman of the Indiana State Highway Commission, and president of the American Association of State Highway Officials, who spoke on "The Postwar Federal-Aid Highway Program." He emphasized the difficulty of developing a program of federal aid which would be adequate and at the same time would meet varying demands as to state distribution. Interesting discussions on this subject were presented by B. C. McCurdy, county superintendent of highways, of St. Clair County, Illinois, and by Harry F. Thomson, vice-president, General Material Company, St. Louis. Mr. Thomson, by the way, was the efficient general chairman of the Spring Meeting Committee.

A third paper was presented by Col. William N. Carey, chief engineer, Federal Works Agency, on "War Jobs and Then What?" This was an eloquent appeal for national development when peace arrives. A. P. Greensfelder, of the Fruin-Colnon Contracting Co., St. Louis, contributed a forward-looking discussion of Colonel Carey's paper.

The appearance of a number of the papers presented at the St. Louis Meeting in Society publications is to be expected. It was the general feeling that the technical program of the meeting had been intelligently prepared and successfully carried out. It was serious, it was constructive, it was thought provoking, and it was stimulating.

Large Supply Depot Proves Interesting

The final event, which came promptly after the noon adjournment of the Thursday morning session, was a trip to the Engineer Depot at Granite City, Ill. A special train leaving from the Union Depot transported the large party to nearby Granite City across the river. En route there was a good view of the flooded Mississippi. Ample levees protect the Granite City industries, as well as the Engineer Depot adjacent to the river. Immediately on arrival, a generous lunch was provided through courtesy of the officials of the depot. The inclusion of beefsteak on the menu was a welcome surprise to many. Most of the remainder of the trip during the afternoon was by train, with frequent stops so that the party could disembark and get a closer view of all stored materials, warehouses, and packing operations.

Statistics of this depot, if available, would seem unbelievable. Suffice it to say that vast numbers of earth-moving machines, miles of piping, and other miles of warehouses were shown. Considering that this represented but a small fraction of the might of a great nation at war, the demonstration was most significant.

The number enjoying this tour was limited to 200, and the quota was filled. Slightly larger was the attendance at the Wednesday dinner. Total registration at the meeting was almost 350, which gives an idea of the success of the local effort and the interest aroused by the fine program. The ladies enjoyed trips and luncheons both on Tuesday and Wednesday; and of course they added immeasurably to the Wednesday evening and Thursday afternoon events. Altogether, the St. Louis Spring Meeting must go down in the records as a most pleasurable and successful series of events.

Labor Hoarding Racket Operated by "Engineering Service" Companies

FROM VARIOUS sources, believed to be reliable, the following material has been gathered in regard to the pernicious practices of so-called "Engineering Service" firms.

Capitalizing on critical shortages of skilled mechanics, a number of employment brokers have cornered the market on certain classes of labor. Particularly damaging to the war effort, this practice has also cast a stigma on the engineering profession because of the general use of "engineering service" as a term to describe activities of these companies. Five major agencies of the Federal Government have denounced such activities and have forbidden war contractors to patronize such concerns.

Typical of the extortive practice is the following case. A large aircraft factory is reported to have needed 25,000 employees of many descriptions. A large percentage had of necessity to be skilled mechanics. The wage schedule approved by the Wage Stabilization Unit of the U.S. Treasury Department, listed the following hourly wages for a few of the many classifications: Tool designer, $1.75; loftsman, $1.50; production planner, $1.45.

Every conceivable method to recruit these workers was resorted to, including the U.S. Employment Service. Nowhere near the number required were thus obtained. Then the "Engineering Service" firms came into the picture. Several such promoters offered to furnish the needed workmen at from $2.50 to $4.50 per man-hour plus a "maintenance fee" of $48 per week per man.

Such workmen are recruited in areas other than the location of the plant. They are employed by the labor brokers at a rate somewhat higher than that prevailing in the area of recruiting and are farmed out to legitimate employers who pay not the workman but the labor broker. He pockets the difference between the rate he charges and the wage in turn paid to the workman—sometimes amounting to more than 100% profit.

The term "engineering service" is a misrepresentation, for the men hired are mechanics—not engineers, and the labor broker furnishes no bona fide engineering direction of activities. The workmen are directly under the supervision of the prime contractor even though paid by the profiteer.

The War Department, the Navy Department, the War Labor Board, the Maritime Commission, and the War Manpower Commission have acted jointly to stamp out this practice. A statement denouncing such detrimental activities has been issued by all these agencies. War contractors have been directed to cease doing business with such concerns.

National Roster Offers Timely Service

SINCE 1940, the National Roster of Scientific and Specialized Personnel in the War Manpower Commission has been the agency of the Federal Government that has served as a central registry for persons possessing professional or scientific qualifications. It is important to the war effort that engineers who possess the necessary qualifications should be registered.

The Roster has been assigned the responsibility of obtaining the best utilization of professional and scientific personnel. It maintains records of those working in war industry as well as those in the armed forces, whether in an officer or enlisted capacity. It seems that recent Selective Service directives may result in the

duction of many thousands of professionally and scientifically qualified young men under the age of 26. Hence it is important that these particular individuals notify the Roster of the branch of the armed forces they are entering, the date and place of their induction and, after induction, their serial number.

Obviously the Roster, as a civilian agency of government, has no responsibility in the assignment of its registrants within the armed forces. At the request of the War and Navy Departments, however, the Roster does furnish advice to the Office of the Adjutant General, War Department, and the Bureau of Naval Personnel, Navy Department, concerning the specialized training and qualifications of those of its registrants who are inducted into the Army or Navy. This information is used as an aid in determining the initial military assignment of the individual.

Conceivably it may become imperative in the future—near or distant—to withdraw a number of professionally and scientifically qualified men from the armed forces in order to assign them to important research or production work in civilian war industry. The Roster's records are sufficiently detailed to permit intelligent selection of persons possessing professional qualifications in practically every kind of specialized field; and it would probably be called upon to assist in any such assignment. It is important, therefore, that persons possessing professional or scientific qualifications register with the Roster and advise it immediately concerning any change in their status. Communications should be addressed to the National Roster of Scientific and Specialized Personnel, 1006 U Street, N.W., Washington 25, D.C.

Local Sections Conference at St. Louis

EIGHTEEN Local Sections of the Society were represented at the Local Sections Conference held in the Hotel Coronado, St. Louis, on Tuesday, April 25. Presiding was Lloyd D. Knapp, M. Am. Soc. C.E., by virtue of his membership on the Society's Committee on Local Sections. From him comes the following brief report of the meeting.

No delegate answered for 6 of the 24 Local Sections eligible to be represented. Further, since the Society's Board of Direction was in session all that day, there were relatively few Board members who could squeeze the time for even a brief attendance at the Conference. However, some thirty to thirty-five other guests from St. Louis and nearby Sections were present. All evidenced great interest, particularly in the discussions on collective bargaining.

Treatment of this important issue of the moment continued most of the day, interrupted only by the luncheon recess. The entire discussion was on a high plane. A few Sections appeared to oppose the proposed amendment, but the majority favored the procedure proposed by the Board. Howard F. Peckworth, M. Am. Soc. C.E., assistant to the Secretary, presented the general subject. Many questions were directed at him, to which he gave clear and concise answers.

Rather arbitrarily, it was necessary for the chairman to terminate this general discussion about four o'clock in order to leave time for presenting another important subject—that of postwar planning. The executive director of studies on this subject, Vincent B. Smith, Assoc. M. Am. Soc. C.E., opened the discussion, which continued on a question-and-answer basis until 5:30 p.m. There was not sufficient time to call on the various representatives for their comments, but a thorough review of the main issues was possible.

During the course of the conference, President Pirnie found time to give a splendid talk on postwar planning. Director George W. Burpee outlined some of the objectives of the Engineers' Council for Professional Development and requested the help of the Local Sections. Members of the Society's staff also were heard. The new representative from Washington, E. L. Chandler, M. Am. Soc. C.E., was introduced and gave a brief outline of his activities. The Society's Manager of Publications, Sydney Wilmot, M. Am. Soc. C.E., mentioned the fine cooperation of Local Section officers in connection with technical papers and other matters of interest suitable for publication by the Society.

As the available time had been exhausted, the meeting closed without taking up the general subject of Local Section activities. The interest of those attending in the live topics presented for discussion made this a most profitable Local Sections Conference.

By-Laws Amended—"Committee on Private Engineering Practice"

FOLLOWING constitutional procedure, the Board formally took action amending "Article IV. Committees," sectional paragraph 11(*c*) of the Society By-Laws, the revision being made effective by the vote at the St. Louis Meeting on April 24. The effect of the amendment is to change the name of the previous Committee on Fees to the "Committee on Private Engineering Practice" and to redefine the duties of that committee.

This revision is self-explanatory, as follows:

> "*The Committee on Private Engineering Practice* shall give attention to all problems confronting engineers in private practice, shall collect, codify and prepare for distribution data relative thereto including the determination of adequate fees commensurate with the value of services rendered, the suggestion of terms for engineering contracts, the recommendation of methods and procedures and other special questions which shall relate to the private practice of engineering. It shall advise upon special problems when requested."

Report on Depreciation to Appear in "PROCEEDINGS"

BY AUTHORIZATION of the Board of Direction, a report on depreciation will be published in the forthcoming June PROCEEDINGS, giving the views of a special committee appointed by the Board. Specifically, the committee's opinions have been prompted by an extensive report on this subject made to the National Association of Railroad and Utilities Commissioners.

In order that members may obtain timely opinions from the point of view of the engineer, this Society report is to be distributed. Further, the subject is to be given a prominent place in the plans for the Cleveland Convention in July. Comments for use on that occasion are invited. Members will wish to note the June PROCEEDINGS in this connection. Communications may be forwarded to the Secretary's office. Any member who wishes to present an oral discussion at the Convention also should inform Headquarters.

The Society report has received the approval of the Board. It was submitted by a committee consisting of Henry E. Riggs, Hon. M. Am. Soc. C.E., as chairman, and Louis R. Howson, N. T. Veatch, and Thomas R. Agg, all Members of the Society.

SOCIETY'S COMMITTEE ON POSTWAR CONSTRUCTION AT MEETING IN WASHINGTON, D.C., WHEN RESEARCH AND DEVELOPMENT DIVISION WAS CREATED

Left to Right, Seated: Dean G. Edwards, Malcolm Pirnie (ex officio, as President of the Society), G. Donald Kennedy (Chairman). Standing: Gustav J. Requardt, Charles T. Leeds, A. J. Ackerman, Hal H. Hale, and E. Lawrence Chandler (Society's Washington Representative). Two Committee Members Were Not Present—Frederick H. Fowler and Frank T. Sheets.

Board Opposes Patronage Measure

MANY ENGINEERS have been disturbed by the prospect that the appointment to, and the holding of, all important technical positions in the government may be made subject to congressional approval. As provided in Senator Kilgore's Bill now before Congress, the so-called "patronage measure," all positions paying $4,500 per annum or more would require that the appointee be approved by the Senate. Discussion in the Board of Direction at its April 25 meeting in St. Louis pointed to widespread dangers that may lurk in such an enactment. Accordingly the Board adopted the following resolution of protest:

"WHEREAS: The Board of Direction of the American Society of Civil Engineers has given consideration to the provisions contained in Section 210 of House Bill 4070, reading as follows:

> 'SEC. 210. No part of any appropriation available for the executive departments and independent establishments (including any agency the majority of the stock of which is owned by the Government of the United States) for the fiscal year 1945 or any subsequent fiscal year contained in this or any other Act shall be (1) paid to any person for the filling of any position for which he or she has been nominated after the Senate has voted not to approve of the nomination of said person, or (2) available to pay the salary of any person at the rate of $4,500 per annum or more unless such person shall be appointed by the President, by and with the advice and consent of the Senate.'

which bill has passed the Senate and has now been referred to a Conference Committee; and

"WHEREAS: Such a law would be in direct controversion to the merit system, under which employees of the Federal Government now function; and

"WHEREAS: A very large number of engineers would be affected by the enactment of such a law; and

"WHEREAS: The Board of Direction believes that such a law would result in detriment both to individuals affected by it and to the public, now, therefore,

"*Be it resolved*, That the Board of Direction of the American Society of Civil Engineers, assembled in regular session this 24th day of April 1944, hereby expresses its disapproval of and opposition to the provisions of Section 210 of H.R. 4070."

Some Yearbook Corrections

IT IS impossible to keep the Society Yearbook up to date, but every effort is made to have it correct when it first appears. Unfortunately, a few errors were included in the 1944 volume. They are noted here in the interest of accuracy.

"ATWOOD, WILLIAM GREENE . . . 211 East Canton Ave., Winter Park, Fla." This is the correct address.

"HARRIS, FREDERIC ROBERT." The spelling was incorrect.

"KELLOGG, FREDERIC HARTWELL." This is the correct spelling, instead of "Kelloff."

"LEGARÉ, THOMAS KEITH . . . Dist. Mgr., War Production Board; Executive Secy., National Council of State Boards of Eng. Examiners, P.O. Drawer 1404, Columbia 56, S.C." Positions have been corrected.

"MOORE, LEWIS BLAFFER (Assoc. M. '28; M. '34), Asst. Chf. Quartermaster, The Panama Canal, Balboa Heights, Canal Zone." Middle name and one membership designation were incorrect. This name and the one following, properly different, were given alike. They are here given correctly, in full.

"MOORE, LEWIS EUGENE (Affiliate '08; Assoc. M. '10; M. '23), Cons. Engr., 113 Beaumont Ave., Newtonville 60, Mass." The address was incorrect.

"STEVENS, JOHN CYPRIAN (Assoc. M. '08; M. '12; Director '32–'34, etc.)." Notation of Member grade was omitted.

"WHITE, WARREN MALELEEL." Middle name was misspelled.

At best, the publication of the Yearbook is an onerous task. As it is concentrated within a few months prior to April each year, it regularly requires extra editorial assistance. Manpower difficulties complicated the work this year. Ordinary sources of special assistance were not available. Therefore it was necessary to utilize such temporary helpers as were obtainable.

The errors listed should have been caught during the course of preparing the Yearbook. Other corrections may now be in order because of changes that have occurred since February 1, the closing date for the Yearbook, or perhaps because of failure to inform the Society promptly. No attempt has been made to include here changes in these latter categories, nor is it practicable to try to bring the Yearbook up to date month to month by the publication of such corrections.

The Engineer in Foreign Service

IX. Correspondence from a Member Somewhere in Italy

By LT. L. R. HENDERSON, JUN. AM. SOC. C.E.

THERE is little I can tell you except we have engaged the enemy often and are well acquainted with the Luftwaffe. I participated in the great battle for Cassino. Oftentimes when I've gazed across the valley or hills upon the enemy positions from an observation post, I've imagined myself like "Stonewall" Jackson viewing a battleground of the historic Shenandoah Valley. Then I'd shudder at the realism of standing before the very war machine that had conquered all of Europe. Most of the time, however, the whole affair loses any historic proportions and is purely a personal conflict of life and the terror of screaming shells and a gamble against sudden violent death in the mud and rubble where armies pass over and forget. Some men crack completely and are useless but most of them carry on with the hope of somehow, someday getting home. That one hope of home sustains more men than all other things combined. Heroes and brave men are made in the newspapers; at the front only a fool is not scared. Confronted by death and destruction, there is no alternative for the strong or the weak but to show courage and pray.

News from the home front of strikes, high wages or politics in the war effort often puzzles and makes the soldiers feel bitter toward various groups at home. As at home grievances arise, and unequal conditions and injustices will be evident to a soldier just as to a worker. But the soldier is so vividly aware of many less fortunate than himself who have made great sacrifices without compensation, that he knows justice is not dealt out evenly as unions would like to guarantee.

The people at home never will understand the soldier overseas—that is evident from newspaper and magazine articles. They can no more understand what war is from across an ocean than a rear echelon soldier can visualize the front from 35 miles behind the lines. There is no way to reconcile two so different ways of life; that I believe is the principal reason that war veterans are reluctant to discuss their experiences. They know they can never be understood.

Soldiers over here have a particular distaste for the motion pictures that are so kindly shown to us whenever possible. I do not know how they are taken at home but the inevitable flag waving and patriotic displays disgust us with their lack of realism.

Pardon my preaching but maybe you can appreciate our feelings and remember we still have feelings.

Appointments of Society Representatives

JULIUS ADLER, M. Am. Soc. C.E., and LYLE L. JENNE, Assoc. M. Am. Soc. C.E., were appointed to represent the Society at the 48th annual meeting of the American Academy of Political and Social Science, which took place in Philadelphia on April 14 and 15.

RALPH BUDD, Hon. M. Am. Soc. C.E., has been reappointed the Society's representative on the Hoover Medal Board of Award for the six-year term ending in May 1950.

HAL H. HALE and CHARLES T. LEEDS, Members Am. Soc. C.E., have been appointed members of the Society's Committee on Postwar Construction.

E. L. MOSLEY, M. Am. Soc. C.E., has been elected a member of the Executive Committee of the Power Division to fill the unexpired term of ROYCE J. TIPTON, who is ineligible to serve longer because of his election as Director of the Society.

News of Local Sections

Scheduled Meetings

DAYTON SECTION—Luncheon meeting at the Engineers' Club on June 19, at 12:15 p.m.

GEORGIA SECTION—Luncheon meeting at Davidson's Tea Room on June 2, at 12:30 p.m.

LOS ANGELES SECTION—Field day meeting at the Oakmont Country Club on June 15, at 5 p.m.

MIAMI SECTION—Dinner meeting at the Royal Center on June 1, at 7 p.m.

PHILADELPHIA SECTION—Annual meeting at the Engineers' Club on June 13, at 7:30 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:15 p.m.

SAN DIEGO SECTION—Dinner meeting at the U.S. Grant Hotel on June 22, at 6:30 p.m.

SAN FRANCISCO SECTION—Regular bi-monthly dinner meeting at the Engineers' Club on June 20, at 5:30 p.m.

TENNESSEE VALLEY SECTION—Annual spring meeting of the Tennessee Valley Section on June 10; inspection trip by the Knoxville Sub-Section to T.V.A.'s Fontana Dam on June 10.

TEXAS SECTION—Regular monthly meetings of the Dallas Branch at the Adolphus Hotel every first Tuesday at 12:15 p.m.; luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on June 12, at 12:15 p.m.

UTAH SECTION—Dinner meeting at the Hotel Utah on June 2, at 6:30 p.m.

Recent Activities

BUFFALO SECTION

At the luncheon meeting held on April 18, Charles H. Sells gave interesting highlights on his experiences in Iraq and Iran during 1942 and 1943, when he was engaged in building harbor, highway, and bridge facilities for the British 10th Army. Mr. Sells, who is now Commissioner of Public Works of the State of New York, gave a graphic account of what was accomplished without suitable materials, equipment, and specially trained personnel. The audience was particularly impressed by his description of the construction of 985 ft of all-welded construction in 85 working days, using miscellaneous salvaged structural steel on concrete piers. Water for mixing the aggregate had to be hauled three miles, and the work was done under sunshine temperatures averaging 162 deg.

CENTRAL ILLINOIS SECTION

A talk on projectiles, small arms, and munitions comprised the technical program at the April meeting of the Section, which took place in Springfield on the 4th. This was given by Prof. Harold L. Walker, head of the mining and metallurgical engineering department at the University of Illinois. An interesting exhibit of sample shells, projectiles, cartridges, and rifles, as used at present by the Army, was available for examination.

CENTRAL OHIO SECTION

"The Application of Soil Studies to Highway Construction in Ohio" was the topic of discussion at the April dinner meeting of the Section, the principal speaker being Harry W. Marshall. Mr. Marshall is geologist for the Ohio State Highway Testing Laboratory. A discussion of business matters preceded the technical session.

CINCINNATI SECTION

Speakers and guests of honor at the annual meeting of the Section, which was held on April 22, were Malcolm Pirnie, President of the Society, and George T. Seabury, Secretary. Mr. Pirnie outlined the role of the civil engineer in postwar planning and indicated that the Society is taking an important part in this planning. Mr. Seabury's subject was the non-technical activities of the Society. New officers for the Section were inducted during the evening. These are Henry Kercher, president; Bart J. Shine, vice-president; and Warren W. Parks, secretary-treasurer.

CLEVELAND SECTION

The March dinner meeting of the Section was devoted to a discussion of the subject of collective bargaining, the principal speaker being Howard F. Peckworth, assistant to the Secretary of the Society. At the regular monthly dinner meeting, on April 14, members heard F. H. Waring speak on recent sanitary developments in the Mahoning Valley. Mr. Waring, who is chief engineer for the Division of Sanitary Engineering of the Ohio State Department of Health, pointed out that increased industrial water usage in the Mahoning Valley has greatly depleted the average stream flow of the Mahoning River, and when dry weather comes the water must be used over and over again. At the same time, increased industrial pollution of the river makes it necessary that certain remedial measures be taken at once, but complete treatment of industrial wastes and domestic sewage is not possible without dilution. Thus adequate sewage treatment depends on an increased water supply. Proposals for increasing low-flow storage favor the building of two new reservoirs.

COLORADO SECTION

On April 10 the members heard A. E. Perlman, chief engineer of the Denver and Rio Grande Railroad, speak on "The Railroad of Tomorrow." Mr. Perlman emphasized the place of the research laboratory in solving the multitudinous problems involved in operating railroads in a wide variety of climatic conditions. The use of polaroid lenses to study the flow patterns in model; a solution of bentonite to minimize cinder-cutting in locomotive boilers; the use of the gamma ray to improve welding technique; and the control of locomotive boiling foam were a few of the many examples cited.

CONNECTICUT SECTION

The technical program at the February dinner meeting of the Connecticut Section—held in New Haven on the 24th—consisted of a talk by Clarence W. Dunham, associate professor of civil engineering at Yale University. Professor Dunham's subject was foundation problems encountered in the construction of a low-grade ore project for the Cananea Consolidated Copper Company in Mexico, which is still in process of construction. Excellent slides added to the interest of the lecture.

HAWAII SECTION

On April 12 Harrison P. Eddy, Jr., Boston (Mass.) consultant, addressed a meeting of the Hawaii Section in Honolulu. Mr. Eddy read a paper explaining the position of the Society on the subject of collective bargaining. A general discussion from the floor followed. During the evening the following new officers were elected for the coming year: Benjamin F. Rush, president; A. E. Lindau, vice-president; and Walter H. Samson, secretary-treasurer.

KANSAS SECTION

At the meeting of the Kansas Section, which took place in Topeka on April 14, Lt. Col. C. J. Frankforter, commanding officer for District No. 4 of the Seventh Service Command, spoke on "Powder and Explosives." Colonel Frankforter, who was a member of the chemical engineering faculty at the University of Nebraska prior to the war, illustrated his talk with a demonstration of the properties of many powders and the performance of detonators currently in military use.

KENTUCKY SECTION

A joint meeting of the Section and its Junior Forum took place on April 21. Talks by two Juniors—W. A. Heitmann and R. W. Pride—had been scheduled for the technical program. The former discussed engineering features of the Fort Knox Experimental Laboratory, while Mr. Pride's subject was "Surface Water Investigation by the U.S. Geological Survey," with which he is connected. Mr. Heitmann is associate engineer for the U.S. Engineer Office in Louisville. At the conclusion of the program Frank C. Tolles, Director of the Society from District 9, discussed postwar planning and collective bargaining.

LOS ANGELES SECTION

"The Functions of Freeways" was the topic of discussion at the April meeting of the Section, the speaker being Fred J. Grumm, assistant state highway engineer for the California State Division of Highways. Freeways, Mr. Grumm stated, loom as an appropriate solution to the many difficulties encountered in handling large volumes of traffic in urban areas. The problem in each city is individual and must be part of a functional study of that city.

MARYLAND SECTION

Several high-ranking Navy officers were guests of the Section for the April dinner meeting. Gustav J. Requardt, former Director from District 5, reported on the three-year term of his directorship. Then Comdr. H. B. Buse spoke on the activities and accomplishments of the Seabees. Commander Buse is assistant director of the construction department of the Bureau of Yards and Docks. A sound motion picture, entitled "Seabees in Action," concluded the program.

MID-SOUTH SECTION

The spring meeting of the Mid-South Section took the form of an all-day session, held in Little Rock, Ark., on April 28. During the morning session papers were presented by George L. Fry, assistant engineer of plans and surveys for the Arkansas State Highway Commission, whose subject was "Postwar Highway Design," and W. L. Whittemore, who discussed design features of the Norfork Dam. Following discussion of the two papers, the group recessed for lunch. Speakers scheduled for the afternoon program were Thorald Field, whose subject was the "Disposition of Raw Material Stockpiles and War Industrial Plants," and A. M. Lund, who delivered a paper on the part of the smaller war-plant corporations in the postwar program. Mr. Lund is district manager for Arkansas of the Smaller War Plants Corporation. The rest of the afternoon was devoted to business discussion.

NORTHWESTERN SECTION

At the regular monthly meeting of the Section—held at the University of Minnesota on May 1—the speaker was C. C. Singleton, who gave an illustrated talk on "Recent Developments in Concrete Structures." Mr. Singleton, who is regional structural engineer for the Portland Cement Association, emphasized the benefits accruing on war projects from architect, engineer, and contractor cooperation.

PANAMA SECTION

The Panama Section reports that, during the winter, the members were guest of the Dredging Division of the Panama Section for a tour of inspection of the Pacific side of the Third Locks. The occasion afforded an excellent opportunity to see all the details of suction and dipper dredging, and a drill boat in operation. The trip was in charge of J. M. Hearne, J. D. Stephens, and Forrest L. Dye, all representatives of the Dredging Division. On March 6 the group met in Balboa to hear William Badders, master diver for the Panama Canal, discuss his many years of experience in diving and describe the methods and equipment used. Mr. Badders also described salvage jobs on which he has been engaged.

PHILADELPHIA SECTION

The story of the Big Inch Pipe Line attracted a large gathering for the April 11th meeting of the Philadelphia Section. J. B. Adoue, Jr., pipe line engineer and executive assistant to the Pipe Line Coordinator, touched on the background and future possibilities of the project and showed the details of construction. The Big Inch line has a capacity of 300,000 barrels of oil per day, Mr. Adoue stated. The oil moves through the line at a speed of 108 miles per day, taking about 14 days to cover the full length of the line. The power bill to operate the line is over five million dollars a year. Moving pictures, showing the actual construction of the line, concluded Mr. Adoue's talk.

PITTSBURGH SECTION

On April 21 the Section celebrated "President's Night." A reception and dinner for President Pirnie and Secretary Seabury preceded the meeting proper, which was addressed by both guests. Mr. Pirnie spoke on "The Position of the Engineer in Postwar Society," while Mr. Seabury discussed miscellaneous Society activities and brought the collective bargaining situation up to date. The May meeting took the form of a joint session with the civil section of the Engineers' Society of Western Pennsylvania. Following a brief business session, C. F. Goodrich, director of the Society and chief engineer of the American Bridge Company, spoke on "The Structural Steel Fabricating Industry—Past, Present, and Future." A moving picture, shown through the courtesy of the American Institute of Steel Construction, concluded the program.

SACRAMENTO SECTION

There were four meetings in April. Maj. Gen. William Lynd, who commands the Fourth Air Force, addressed the Section on the 4th on "The Air Force Engineer in the War." General Lynd emphasized the importance of this new engineer service in the prompt expansion of airport facilities at home and in advanced areas. Irvin Ingerson, of the Sacramento Section, and H. J. Brunnier, of the San Francisco Section, spoke at the next two meetings on the Central Valley project and Canal Zone expansion, respectively. At the final meeting of the month, Assistant Attorney General James H. Oakley outlined the regular procedures of his office, particularly in relation to engineering problems.

SAN FRANCISCO SECTION

A symposium on the Pit No. 5 Project of the Pacific Gas and Electric Company comprised the technical program at the regular bi-monthly dinner meeting of the Section, which took place on April 18. Speakers were I. C. Steele, chief engineer of the company, who described the design and physical features of the project; O. W. Peterson, head of the construction department, who outlined the contractual and construction organizations; and H. W. Haberkorn, engineer of hydro construction, who described the building of the dam, powerhouse, tunnels, penstocks, and appurtenant structures. The talks were illustrated with lantern slides.

The program at the March meeting of the Junior Forum consisted of talks by Howard Russell, Jr., and William R. Seeger, both members of the Forum. The topic for general discussion was "The Engineer—Technician or Administrator."

SEATTLE SECTION

On March 27 the Seattle Section sponsored the nineteenth annual joint meeting of local branches of the Four Founder Societies. Following dinner and a musical program—presented by Max Dolin—W. Walter Williams, speaker of the evening, was introduced. Mr. Williams, who is chairman of the Washington State Defense Council, discussed postwar prospects for the nation and for the Pacific Northwest in particular. Mr. Williams stressed the fact that many opportunities for the future development of the Puget Sound region exist. At the April meeting Jean Ewen, of the Public Roads Administration, presented colored movies of the location and construction of the Alaska Highway and discussed various features of the work.

TOLEDO SECTION

A dinner meeting of the Toledo Technical Council, of which the Toledo Section is a participating group, took place on April 24. The speaker of the evening was Mandell Lerkowsky, who is in charge of the engineering development of the helicopter at Wright Field, Dayton, Ohio. Mr. Lerkowsky substituted most competently for Col. H. F. Gregory, who had been scheduled to speak on the postwar possibilities of the helicopter but was prevented from doing so by military duties.

WEST VIRGINIA SECTION

Members of the West Virginia Section met in Wheeling on April 28 for an after-luncheon and inspection trip, followed by dinner and an evening technical meeting. During the luncheon a paper was read by Howard A. Kelly, chief engineer of the Wheeling Stamping Company, who described the work being done by his company and its wartime problems. Later Mr. Kelly conducted the group through the plant. The speaker at the evening dinner meeting was R. P. Davis, dean of the college of engineering at West Virginia University, who gave an illustrated lecture on recent developments in foundation design. Dean Davis is a former Director and Vice-President of the Society.

ITEMS OF INTEREST

About Engineers and Engineering

S.P.E.E. Committee Reports on Postwar Engineering Education

The practice of indiscriminate admission of engineering students to American colleges, wherever it exists, should be abandoned in favor of greater selectivity. This was one among many recommendations made by the Committee on Engineering Education After the War, appointed by the Society for the Promotion of Engineering Education. The twenty-one members of the Committee include the following eight Members of the Society: J. W. Barker, N. W. Dougherty, H. T. Heald, F. T. Mavis, E. L. Moreland, H. S. Rogers, C. R. Young, and H. P. Hammond, Chairman. The conclusions of the report are here condensed. The report is published in its entirety in the May issue of the "Journal of Engineering Education."

Conclusions of Report

War experiences have altered temporarily the norms of engineering education but have not indicated the desirability of radical changes. With the cessation of hostilities, wartime expedients should give place as rapidly as practicable to normal functions and the healthy processes of evolution should be resumed.

Events have shown one major extension to be needed, namely, a more positive indoctrination in civic and professional responsibilities. It has also become increasingly clear that secondary education needs to be strengthened, especially in mathematics and science, as a means of preparing for collegiate engineering education, and means to this end must be sought vigorously.

Matters relating to administration and management which conform to engineering modes of analysis and procedure have a valid place in engineering education. Trends in industry also make opportune increased attention to the production of industrial materials and of consumer goods, and to the recruitment of the production personnel as distinct from research and planning personnel.

The restoration of graduate work and its extension in scope to include all areas of advanced specialization should be immediate postwar goals. Instruction and research should be developed as complementary and coordinate functions.

The Committee believes that both industry and the engineering profession would benefit from a clearer understanding of the relative functions of technical institutes of intermediate type and engineering colleges, and from the larger development and strengthening of the former. This can be aided by—in fact can scarcely be accomplished without—the establishment of appropriate measures for the recognition of technical institutes by the engineering profession and the acceptance of their graduates by industry and government for a wider range of subprofessional technical occupations.

Immediate Postwar Problems

Two problems stand out as of great importance: (1) Devising more valid means than have been employed in the past for selecting and admitting students and insuring better preparation in secondary schools, and (2) building up faculties not only to the prewar level of effectiveness but well above that level.

Of more immediate concern is the planning of appropriate educational programs for returning veterans in order to permit them to enter productive pursuits in the minimum time consistent with sound practice. This can and will be done. We would call attention especially in this connection to provision of postgraduate work, either full time or part time, for those who desire and can profit by it.

If, as present indications seem to suggest, there is to be a reaction away from the wartime accelerated academic calendar and if conditions of universal military service are such as to permit freedom of choice in relation to this matter, it may be necessary to meet the criticism of those who see serious waste in permitting valuable educational facilities to be operated for less than a full calendar year. We have referred previously to the values derived by students from the experience and the maturing influence of employment in industry. Engineering colleges might well establish systematic means of aiding students to secure employment that will afford the right sort of experience, and of requiring such experience as a prerequisite to graduation. Certain colleges achieve this result through the cooperative plan.

If educational programs are to be in regular operation for less than the full calendar year, it is equally important that vacations be used profitably by teachers. It seems appropriate, and even necessary, that they be expected to spend vacations in industrial employment, research, writing, or other pursuits that will keep them abreast of current developments in science and engineering or otherwise promote their professional advancement.

Finally, and of the utmost importance during postwar years, will be the inevitable problems of financing higher education during a period of world-wide economic rehabilitation. One not inconsiderable aspect of this matter will be the necessity of restoring to normal efficiency laboratory facilities worn out or damaged by war usage. The war has caused a suspension of replacement of items of equipment that have become obsolete; others have undergone abnormal wear and deterioration; provision must be made to make good these deficiencies. In sum, a period of serious financial difficulty lies ahead.

Wide fluctuations in enrolment of engineering students are being experienced. These fluctuations occur not only in total numbers but in distribution by years and curricula. It is to be anticipated that this condition will continue into the postwar period. It is possible also that in the immediate post-armistice years there will be a considerable influx of new students at the same time that veterans are returning to complete their curricula. How long this condition will continue is a matter of conjecture, but it seems plain that the resulting problems will be severe in the internal administration of engineering colleges.

If at the same time there is to be a permanent increase in enrolment in science and engineering, and if colleges of engineering are to occupy a larger place and exercise a more general function than they do at present in the scheme of collegiate education in this country, it is not only appropriate but necessary to plan in advance for the facilities and staffs which these changes will require.

Book of Hydraulic Tables Now Available

Announcement has been made of the availability of a second edition of "Hydraulic Tables," prepared under the direction of the Chief of Engineers, U.S. Army, by the Mathematical Tables Project of the Work Projects Administration for the City of New York. Although this book was prepared primarily for the use of the War Department in its flood-control work, it is believed that it will prove useful to hydraulic engineers generally.

The present volume corrects the errors in the first edition. Copies of the new edition may be obtained from the Superintendent of Documents in Washington, D.C., at a cost of one dollar a copy.

A.S.A. Publishes Building Codes for Masonry

In the interests of better design and construction of buildings, the American Standards Association has announced publication of the American Standard Building Code Requirements for Masonry. This is one of a related series of building standards that are being developed by technical committees of the American Standards Association, and the first to be completed in the field of masonry.

Covering in detail the materials commonly used in non-reinforced masonry, the standard deals with performance requirements as well as the design and workmanship of masonry used in building. It is divided into 19 sections, plus an appendix, which consists of explanatory matter referring to various parts of the recommended code requirements. The appendix is not actually a part of the requirements, but is presented as background material to supplement the code.

The standard has been developed under the technical leadership of the National Bureau of Standards, through the procedure of the American Standards Association. The objectives of the building code program and related information are described in a pamphlet, "Building Code Standardization," which may be obtained free from the American Standards Association, 29 West 39th Street, New York 18, N.Y. The American Standard Building Requirements for Masonry may be ordered from the American Standards Association at the same address at 50 cents a copy.

Public Roads Administration Approves Employment of Consultants

EMPLOYMENT of private engineering organizations by state highway departments was approved by the Public Roads Administration in a memorandum issued October 22, 1943. This general administrative memorandum No. 244 lists three general types of agreements that can be made by the state departments with consultants. These follow:

"1. An agreement providing for a definite and reasonable fee for engineering services.

"2. An agreement providing for specific rates of pay for each class of employee used on the work with a maximum total cost specified.

"3. An agreement providing for payment of actual salaries and cost of materials plus a definite and reasonable fee for direction."

Revised Specification Procedure Suggested by Producers' Council

DISSATISFACTION with operation of the "or equal" clause in construction specifications has led to the development of a new procedure by the Producers' Council. The plan advocated would eliminate the objectionable clause by basing all bids on one specified product. Opportunity would be given bidders to submit alternate bids on similar products which they think will fill requirements.

Using a particular product as a basis for bidding need not necessarily show a preference if opportunity is given for alternate bids. Specifiers can rotate products named on one job after another so that there will be no charge of unfair consideration. For a complete explanation of the procedure a pamphlet, "Bidding Practices for Building Materials," may be obtained on request from The Producers' Council, Inc., 815—15th Street, N.W., Washington 5, D.C.

N. G. Neare's Column

Conducted by

R. ROBINSON ROWE

DINNER at the Engineers Club had been a round-table discussion of collective bargaining, with the "unioneers" outnumbering but not out-talking the "nongineers." It ended when Joe Kerr suggested, "Let's give up and ask Professor Neare for the answer!"

"The trouble with that problem," hedged the Professor, "is that it has too many answers. I'd rather talk about the Eniwetok Parade Ground with its flagpole 100, 200, 300 and 400 ft, respectively, from corners of the equilateral field."

"That doesn't have even one answer," countered Joe. "Any three of those distances determine the square and the fourth won't jibe."

"But the Professor didn't specify a square," said Cal Klater. "A rhomb will do and, since its diagonals bisect each other at right angles, we can draw it (*ACBD*) with its vertices on the four concentric circles about a flagpole origin (Fig. 1). Making its diagonals parallel to the axes and letting x and y be coordinates of the center of the rhomb, we can express them as means of coordinates of vertices, thus:

$$2x = \sqrt{200^2 - y^2} - \sqrt{100^2 - y^2}$$

$$2y = \sqrt{400^2 - x^2} - \sqrt{300^2 - x^2}$$

These simultaneous quartics yield only one real solution, $x = 53.622$ and $y = 50.610$, from which it is easy to compute coordinates of two vertices and then the side of the rhomb, 373.00 ft.

"The signs of the radicals must be as I have shown or the solution will be remote from the flagpole, like rhomb $A'C'B'D'$. Connecting the circles in a different order will give rhomb $A''C''D''B''$, which misses the flagpole by several feet. The order $ABCD$ is impossible."

"Cal has an eloquent figure and the right answer," agreed Ken Bridgewater, "but it's easier to use the semi-diagonals of the rhomb as parameters and derive the general equation:

$$2S^3 - (A + B + C + D)S^2 + [(A + C)(B + D) - 2AC - 2BD]S + (AC - BD)(A - B + C - D) = 0$$

where S, A, B, C, and D are the squares of the side and the four distances to consecutive vertices, respectively. For the given data,

$$S^3 - 1{,}500S^2 - 855{,}000S + 1{,}400{,}000{,}000 = 0$$

and $\sqrt{S} = 372.996826$ ft."

"Topologically," added Isidore Knobbe, "the problem is equivalent to finding equal diagonals for a quadrilateral with sides 100, 200, 300, and 400 at random."

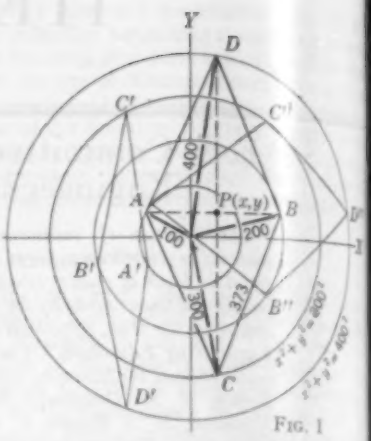


FIG. 1

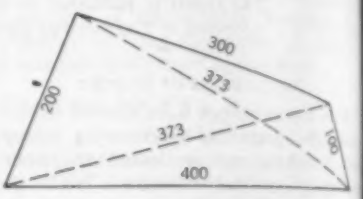


FIG. 2

"As in Fig. 2," concluded the Professor, "but where is the flagpole, topologically? Competitively, our new puzzler comes from a Seabee who just established a secret radio station on an island that the Japs still think they own. He topped a 200-ft tree for his mast. From a top spider he ran 6 wires to the ground—guys to each of 4 anchors in a square pattern and 2 vertical leads. The wire would have just girdled the square. Three of the guys were 350, 450, and 550 ft long; how long was the fourth guy?"

[*Collective Cal Klater was or were Leon Beskin, Coy W. Borders, Isidore Knobbe (Joseph S. Lambie), Edward Soucek, Richard Jenney (with general solution), Karl V. Steinbrugge, O'Kay (Otto Koch), L. C. Hollister, and Lt. Cmdr. (of Seabees) Kam Pewter (Walter Steinbruch).*]

NEWS OF ENGINEERS

Personal Items About Society Members

DONALD H. CONNOLLY, major general, U.S. Army, is one of thirty-four officers and men of the Persian Gulf Service Command who have been decorated by Premier Stalin for their work in "placing supplies in Russia's hands." General Connolly, who is commander of the Persian Gulf Service Command, received the Order of Suvorov, Second Class.

THOMAS W. FLUHR has opened an engineering office in New York City. Mr. Fluhr, who was formerly with the New York Board of Water Supply, will specialize in geological investigations and reports on engineering projects.

GEORGE E. STREHAN has severed his connection as head materials engineer for

...e Projects Division of the War Production Board in Washington, D.C., in order to resume his engineering and architectural practice at Leonia, N.J.

B. J. LAMBERT, professor and head of the department of civil engineering at the University of Iowa, is retiring from active leadership of the department, which he has headed for forty-two years. A scholarship fund, named in his honor, has been established by engineering alumni of the university. The fund will be administered by the engineering faculty to further Professor Lambert's ideals in education.

THOMAS R. CAMP announces that he has resigned as associate professor of sanitary engineering at Massachusetts Institute of Technology in order to open consulting engineering offices in the Statler Building in Boston. Mr. Camp will specialize in water works, sewage treatment, and flood control.

STANFORD E. ABEL has been promoted from the rank of captain in the Corps of Engineers, U.S. Army, to that of major. A veteran of the Guadalcanal and New Georgia campaigns in the Solomons, Major Abel now has an assignment as site plans engineering officer of the South Pacific General Depot, with headquarters in New Caledonia.

A. F. PLANT is now vice-president and director of The Austin Company, engineers and builders of Detroit, Mich.

JOHN C. BISSET was recently promoted from the rank of major in the Corps of Engineers, U.S. Army, to that of lieutenant colonel. Formerly city engineer of Dallas, Tex., Colonel Bisset was commissioned in July 1942 and has been on duty in New Orleans, La., since October 1943, as post engineer.

HARVEY P. JONES announces that Thomas B. Henry will be associated with him as a partner and that the engineering practice formerly carried on under the name of H. P. Jones and Company will be continued by the new firm of Jones and Henry in the Toledo Trust Building, Toledo, Ohio.

JOHN S. BARLOW, consulting engineer of Dallas, Tex., has received the Meritorious Civilian Service Award of the Bureau of Yards and Docks in ". . . recognition of the excellent services rendered over and beyond those normally required in connection with his duties in the construction program of the Bureau." Mr. Barlow has been serving as officer-in-charge of construction of the Naval Air Station at Corpus Christi, Tex.

ROBERT B. BROOKS, St. Louis (Mo.) consultant and former Director of St. Louis Streets and Sewers, has been appointed a member of the St. Louis City Plan Commission. Mr. Brooks is a former Director of the Society.

F. H. FRANKLAND announces that he has resigned as director of engineering for the American Institute of Steel Construction, in order to open his own consulting offices at 271 Madison Avenue, New York 16, N.Y.

THOMAS J. SETTE has been promoted from the rank of ensign in the Construction Battalions of the U.S. Navy to that of lieutenant (jg). He is stationed in Alaska.

ROBERT E. CYPHERS, JR., formerly of the Hydraulic Data Division of the Tennessee Valley Authority, is now a lieutenant (jg) in the Civil Engineering Corps of the U.S. Naval Reserve.

GEORGE R. SCHNEIDER, lieutenant colonel, Corps of Engineers, U.S. Army, has been appointed acting district engineer for the Little Rock (Ark.) district.

DECEASED

JEREMIAH AHERN (M. '04) retired engineer of Dixon, Calif., died in a hospital there on April 19, 1944, at the age of 83. Mr. Ahern was with the U.S. Geological Survey from 1883 to 1892 and, again, from 1895 to 1902. In the latter year he became connected with the U.S. Reclamation Service in charge of reclamation work in northern Wyoming, including the building of Shoshone Dam. For some years prior to his retirement (in 1940) Mr. Ahern maintained a consulting practice in Dixon.

JAMES PENNELL ANDERSON (M. '31) engineer of maintenance of way for the Nashville, Chattanooga, and St. Louis Railway, died suddenly in Atlanta, Ga., on April 15, 1944. For many years a resident of Atlanta, Mr. Anderson was for eighteen years division engineer for the Nashville, Chattanooga, and St. Louis Railway. He had recently been promoted to the rank of engineer of maintenance of way, and was soon to have been transferred to Nashville, Tenn.

LYNN MOORE BURROWS (Assoc. M. '24) president of the Niagara Falls International Bridge Company, of Albion, N.Y., died on February 10, 1944. He was 60. Mr. Burrows served on the construction of the New York Barge Canal. Later (in 1932) he was engaged on the design and construction of improvements to the Niagara Railway Arch Bridge and, upon the completion of the work, became connected with the Niagara Falls International Bridge Company.

GEORG CARL GUSTAV SCHLICHTING FRANCK (Assoc. M. '20) president of G. S. Franck and Company, Buenos Aires, Argentine Republic, died on October 31, 1943, though the Society has just heard of his death. Before becoming connected with the G. S. Franck Company, Mr. Franck was resident engineer for the American Trading Company in Buenos Aires.

LESLIE WARREN GODDARD (M. '08) retired civil engineer of Grand Rapids, Mich., died in St. Petersburg, Fla., where he had been passing the winter, on April 6, 1944. Mr. Goddard had been a resident of Grand Rapids since 1890, and for more than forty years was a civil engineer in the U.S. Engineer Office located there. His work was concerned with the construction and maintenance of river and harbor facilities on the east shore of Lake Michigan.

FRANK MINITREE JOHNSON (M. '27) supervisor of surveys for the U.S. Government at Denver, Colo., died on March 27, 1944. Mr. Johnson, who was 71, had been with the British mission that selected a site and built the Assouan Dam on the Nile. From 1905 to 1910 he maintained a private engineering practice in Cheyenne, Wyo. In the latter year Mr. Johnson became supervisor of surveys for the Department of the Interior.

FRANK RHYMAL JUDD (M. '41) retired engineer of Chicago, Ill., died suddenly on March 19, 1944, at the age of 61. Mr. Judd spent practically his entire career with the Illinois Central System, with which he became connected as a draftsman in 1899. He was promoted, successively, to the positions of chief draftsman and assistant engineer, and from 1915 until his retirement (in August 1931) was engineer of buildings.

OLIVIER ODILON LEFEBVRE (M. '26) vice-president of the Quebec Streams Commission at Montreal, Canada, died on March 25, 1944. He was 65. Early in his career Mr. Lefebvre was in the Federal Department of Public Works, later becoming assistant to the Ottawa district engineer. In 1913 he was made chief engineer of the Quebec Streams Commission. Mr. Lefebvre's activities included the regulation of larger rivers for power production.

THEODORE BISSELL PARKER (M. '31) head of the department of civil engineering at Massachusetts Institute of Technology, died at his home in Wellesley, Mass., on April 27, 1944. Professor Parker, who was 55, was chief engineer of the Tennessee Valley Authority from 1935 to July 1943, when he was appointed to the post at Massachusetts Institute of Technology. Under his direction Norris and Wheeler dams were completed, and he had charge of the design and construction of all subsequent TVA structures. Earlier in his career he was with the Electric Bond and Share Company, and from 1922 to 1933 was hydraulic engineer for the Stone and Webster Engineering Corporation. During the first World War Professor Parker served in the Corps of Engineers, U.S. Army, having the rank of captain.

HUGH HARRY PITCAIRN (M. '20) of Harrisburg, Pa., died on February 21, 1944, at the age of 76. Mr. Pitcairn was with the Pennsylvania Railroad for ten years. He then went to the Philippines, where he remained for a number of years—successively as assistant city engineer of Manila, resident engineer for the Philippine and Manila Railway, and engineer for the U.S. Engineer Department on the construction of Corregidor. He had also maintained a consulting practice in Manila. Later Mr. Pitcairn was superintendent of construction for the Foundation Company, of New York, and went to Brazil in a similar capacity for the Electric Bond and Share Company. He was in the Spanish-American War and served overseas for two years in the first World War, with the rank of captain.

MILTON ALLENDER PYLE (M. '40) associate professor of civil engineering at

the University of Maryland, died on April 26, 1944. He was 49. Professor Pyle spent his entire professional career at the University of Maryland, his alma mater. Beginning in 1918 as instructor in civil engineering, he was made assistant professor in 1932 and associate professor in 1943. From 1936 on he was in charge of the survey and drawing departments.

HARRADON STERLING SMITH (M. '10) consulting engineer of Wilkes-Barre, Pa., died at his home near there on April 9, 1944. Mr. Smith, who was 73, had been in private engineering practice since 1896. Earlier in his career (1885 to 1891) he was with the Lehigh Valley Coal Company, and from 1891 to 1896 was consulting engineer for the Rochester and Pittsburgh Coal and Iron Company at Punxsutawney.

MERTON HORATIO WILLIS (Assoc. M. '18) of Seattle, Wash., died on January 7, 1943, though the Society has just heard of his death. He was 63. Mr. Willis spent twenty-five years in Mexico—from 1907 to 1912 on pioneer railway location and construction, and from the latter year on with the Huasteca Petroleum Company, of Tampico, Mexico. He built the company's first oil refinery in Mexico and their plant at Desterhan, La. Later the company was bought by the Standard Oil Company of Indiana, which transferred Mr. Willis to their Lake Maracaibo [illegible] in Venezula. In 1932 illness forced [illegible] return to the United States, where he [illegible] engaged in surveying and general engineering work in the vicinity of Walnut Creek, Calif.

JOSEPH WRIGHT (M. '09) retired engineer of Austin, Tex., died on April [illegible], 1944. Mr. Wright, who was 75, was for many years with the U.S. Reclamation Service (now the Bureau of Reclamation). In this capacity he was engaged on the construction of the Shoshone Project, the Milk River Project, Wilson Dam, and various other projects of the Bureau of Reclamation.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From April 10, to May 9, 1944, Inclusive

ADDITIONS TO MEMBERSHIP

ALDERMAN, FRANK EDWARD (Assoc. M. '44), City Engr., City Hall, South Gate, Calif.

ALMOND, JAMES CLAYTON (Assoc. M. '44), Care, Oregon Shipbuilding Corp., Troutdale, Ore.

ANDERSON, HAROLD ALBERT (Assoc. M. '44), Dist. Mgr., The Austin Co., 19 Rector St., New York 6, N.Y.

BANTZ, BURWELL (M. '44), Director of Highways, State Highway Dept. (Res., 1324 Eskridge Blvd.), Olympia, Wash.

BARKER, WALTER FRANK (Assoc. M. '44), Pres., Steel Erectors, Inc., 24 Commerce St., Room 834, Newark, N.J.

BATHE, GEORGE R. (Assoc. M. '44), Lt. (jg), U.S.N.R.; 3175 Ames Ave., Omaha 11, Nebr.

BIGELOW, EDWARD EUGENE (M. '44), Structural Engr., Stone & Webster Eng. Corp., 49 Federal St., Boston 7, Mass.

BORG, SIDNEY FRED (Assoc. M. '44), Asst. Prof., Civ. Eng., Univ. of Maryland, College Park (Res., 8313 Fiftieth Ave., Berwyn), Md.

BRANDES, RAYMOND LAWRENCE (Assoc. M. '44), Chf. Structural Engr., The Nicholson Co., Inc., 10 Rockefeller Plaza, New York 20, N.Y.

CERDA ESPINOSA, RAUL (Jun. '44), 317 West 56th St., Apt. 424, New York 19, N.Y.

CHALKER, RALPH GILES (Jun. '43), Junior Design Engr., Curtiss-Wright Corp., Lambert Field, St. Louis (Res., 2840 Walton Rd., Overland), Mo.

CHRISTENSEN, RAYMOND EARL (Jun. '43), Aviation Cadet, Air Corps, U.S.N.; Lakeview, Mich.

COENDERS, ANTHONY JOHN (Assoc. M. '44), Field Engr., Am. Steel & Wire Co., 4300 East 49th St., Cuyahoga Heights (Res., East River Rd., Columbia Station, Westview), Ohio.

COWAN, CEDRIC LANGTON (Assoc. M. '44), Civ. Engr., U.S. Engr. Office, Louisville, Ky.

COX, ROBERT LOUIS (Jun. '44), Stress Analyst (Aircraft), Consolidated Vultee Aircraft Corp., Fort Worth, Tex.

DAVIS, DELBERT MAURICE, JR. (Jun. '44), Private, Corps of Engrs., U. S. Army; 65 Green St., Oakland, Md.

DRUEDING, ROBERT JOSEPH (Assoc. M. '44), Prin. Constr. Engrs., U.S.N.; Project Noy Less 5745, 1006 Suthon Ave., Houma, La.

DULIN, JAMES WALTER (Jun. '43), 2d Lt., Corps of Engrs., U.S. Army; 310 Cotton St., Greenwood, Miss.

EVANS, HOWARD TASKER (M. '43), Lt. Comdr., CEC, U.S.N.R., Hunters Point (Res., 341 Crystal Spring Rd., San Mateo), Calif.

EXNER, ROBERT EMIL (Jun. '43), Eng. Draftsman, Douglas Aircraft Co., Inc. (Res., 1093 Sims Ave.), St. Paul, Minn.

FABERMAN, LAWRENCE LEROY (Jun. '44), Carpenter's Mate, Second Class, U.S.N., Port Hueneme, Calif.

FINCH, LEWIS SPANN (M. '44), Chf. Engr., Indianapolis Water Co., 113 Monument Circle (Res., 115 Penway St.), Indianapolis 5, Ind.

GIBSON, GERALD CARLYLE (Assoc. M. '44), Associate Engr., U.S. Engrs., Box 61, Tulsa, Okla.

GOLD, JOSEPH (Jun. '44), Asst., Civ. Engr., Columbia Univ., 116th St. and Broadway, New York (Res., 2171 Seventy-Fifth St., Brooklyn 4), N.Y.

GOULD, WILLIAM RAYMOND (Jun. '43), 2d Lt., U.S.M.C.; 16 Garfield St., Cambridge 38, Mass.

GREENE, WILLIAM KENNETH (M. '44), Designing Engr., Am. Bridge Co., 71 Broadway, New York 6, N.Y.

GROSSMAN, SAM (Jun. '44), Draftsman, Goodyear Aircraft Corp., Massillon Rd. (Res., 350 Cloverdale Ave.), Akron 3, Ohio.

GYONGYA, GEORGE EDWIN (Jun. '44), With U.S. Army; 136 River Drive, Garfield, N.J.

HARLEMAN, DONALD ROBERT FERGUSSON (Jun. '44), Junior Engr. (Liaison), Curtiss-Wright Corp., Port Columbus Plant (Res., 680 College Ave.), Columbus 9, Ohio.

HEAVENRICH, HERBERT SAMUEL, JR. (Jun. '44), Ensign, CEC-V(S), U.S.N.R.; 2907 North Lake Drive, Milwaukee 11, Wis.

HEDIN, DELBERT NELSON (Jun. '43), Detail Engr., Boeing Aircraft Co. (Res., 3502 West Emerson), Seattle 99, Wash.

HILLIS, WILLIAM LOWRY (M. '44), Civ. Engr., U. S. Engr. Office, 925 New Federal Bldg., Pittsburgh, Pa.

HOENKE, GUY ARTHUR (Jun. '43), 323 East 2d St., Flint, Mich.

HOWARD, ROBERT BURROIS (Jun. '44), Ensign, CEC-V(S), U.S.N.R.; Sturgis, Miss.

INGMAN, GORDON GUNNAR (Jun. '44), Engr., Parker & Hill, 2021 Smith Tower (Res., 5507 Fifty-Fifth Ave., South), Seattle 8, Wash.

JACKSON, FREDERICK BENNETT (Jun. '44), Ensign, CEC-V(S), U.S.N.R.; 129 Rowe St., Auburndale, Mass.

JENNINGS, DONALD CULLER (Jun. '44), Midshipman, CEC, U.S.N.; 524 Harrold Ave., Americus, Ga.

JENNINGS, DOUGLAS STEPHENS (Jun. '44), Civ. Engr., National Advisory Committee for Aeronautics, Langley Field (Res., 226 Lee St.), Hampton, Va.

TOTAL MEMBERSHIP AS OF MAY 9, 1944	
Members	6,041
Associate Members	7,479
Corporate Members	13,520
Honorary Members	36
Juniors	6,204
Affiliates	76
Fellows	1
Total	19,837
(May 10, 1943)	18,750)

JOHNSON, DONALD ELMER (Jun. '43), Ensign, CEC, U.S.N.R., Care, Fleet Post Office, San Francisco, Calif.

KELLER, C. ROLLIN (Assoc. M. '44), Head, Wa[illegible] Constr. Section, Corps of Engrs., 820 New Federal Bldg. (Res., 4723 Idaho Ave.), St. Louis 11, Mo.

KELLY, JAMES FREDERICK (Jun. '44), Harb[illegible] Archt., (P-1) Bldg. 8, Navy Yard (Res., [illegible] East Battery), Charleston 1, S.C.

KINGSBURY, HENRY ALLAN (Jun. '44), Ensign, CEC, U.S.N.; 1 Curve St., Medfield, Mass.

KIRBY, DONALD BARTON (Jun. '44), With U.S.N.R., 102 Highland Ave., Dedham, Mass.

KURLAK, PETER (Jun. '44), Gen. Hull Foreman, Dravo Corp. (Res., 1001 North Rodney St.), Wilmington, Del.

LAVIN, JOSEPH WILLIAM (Jun. '44), Private, Corps of Engrs., U.S. Army; 31 Dunlap St., Dorchester 24, Mass.

LEWIS, HUGH BRADLEY (Jun. '44), 430 Peppe[illegible] Ave., Richmond 21, Va.

LOCKWOOD, ROY VALENTINE (Assoc. M. '44), Associate Structural Engr., Public Works Drafting Room, Norfolk Navy Yard, Portsmouth (Res., 312 West Rodgers Drive, Foxhall, Norfolk 2), Va.

MCLEOD, THOMAS COLE (Jun. '43), Lt., U.S. Army; 604 West Lancaster Rd., Richmond [illegible] Va.

MAUE, JOHN RICHARD (Assoc. M. '44), Superv. Engr., Mike Mannella Co., 500 Jones Law Bldg. (Res., 720 Shady Drive East, Mt. Lebanon), Pittsburgh, Pa.

MOONEY, CHARLES WILLIAM (Assoc. M. '44), Designer, The M. W. Kellogg Co., 225 Broadway, New York, N.Y. (Res., 65 Fairview Ave., North Plainfield, N.J.)

MUSSEY, ORVILLE DUREY (Assoc. M. '44), Associate Hydr. Engr., U.S. Geological Survey, Box 1338, University Station, Charlottesville, Va.

NEWTON, RICHARD FULLER (Jun. '44), Engr. Draftsman, Grade B, Douglas Aircraft Co., 3855 Lakewood Blvd. (Res., 4335 Rutgers Ave.), Long Beach 8, Calif.

NOBLETTE, WILLIAM BO.D (Assoc. M. '44), Lt., Corps of Engrs., U.S. Army, Army Post Office 636, Care, Postmaster, New York, N.Y.

OSKIN, WILLIAM WALKER (Assoc. M. '44), Designer, Bethlehem Steel Co. (Res., 922 West Market St.), Bethlehem, Pa.

OZBAS, HALIL (Jun. '44), Instr., Princeton Univ., Princeton, N.J.

PEIRCE, JAMES BUTLER (Jun. '44), With U.S. M.C.R.; Witch Hill, Topsfield, Mass.

PERRY, THOMAS WALTER (Jun. '43), Insp. Dimensional Control, Goodyear Aircraft Corp., Dept. 38, Plant B (Res., 79 South Balch St.), Akron, Ohio.

POYNOR, JAMES PAUL, JR. (Jun. '44), Supt., Fulcher & Poynor, 518 Cotton States Bldg., Nashville, Tenn.

RANKIN, JAMES MARTEN (Jun. '44), Eng. Apprentice, P.R.R., Div. Engrs. Office, Pennsylvania Station, Toledo, Ohio. (Res., 902 Fifth Ave., Sterling, Ill.)